WATERLOO SANITARY MASTER PLAN

City of Waterloo Sanitary Master Plan Update

September 30, 2024

Prepared for:

City of Waterloo

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Revision	Description	Author	Quality Check	Independent Review
0	Draft MP	HB/SM	DE	JP
1	Final MP	HB/SM	DE	JP
2	Final MP	HB/SM	DE	JP

Sign-off Sheet

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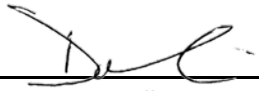
Reviewed by 

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Executive Summary

The City of Waterloo has initiated an update to the 2014 Sanitary Sewer System Master Plan Update. The aim of the Master Plan Update is to accommodate projected increases in population and employment up to 2051, and to account for updated infrastructure. The Master Plan Final Report outlines priority and strategic projects that will ensure the system's efficient and effective operation. The recommendations include implementing best management practices for reducing Inflow/Infiltration (I/I), rehabilitating the system, and optimizing the staging of the sanitary capital program.

The collection system services most residents in the City of Waterloo and also receives flows from the City of Kitchener, the Township of Woolwich, and the Township of Wilmot. The City owns and operates approximately 420 km of sanitary sewers and six sewage pumping stations. Wastewater is conveyed and treated at the Waterloo Wastewater Treatment Plant (WWTP) which is owned and operated by the Region of Waterloo before being discharged into the Grand River.

The Master Plan's recommendations include a series of individual projects categorized into Priority Projects and Strategic Projects, which together form the preferred Master Plan Servicing Strategy. The Priority Projects are recommended for completion within the next five-year cycle, while the Strategic Projects are a 5 to 30-year window which are outlined at a higher level.

The recommendations and estimated costs present capital upgrades to existing infrastructure, at locations where capacity constraints have been identified within the sanitary sewer network: Highpoint Avenue, Austin Drive, Lodge Street, Maple Hill Trunk, Weber Street North, Downstream of Frobisher SPS, Lower Forwell Trunk, and Union Street East.

A comprehensive list of these recommended capital projects and the associated estimated costs is summarized in **Table E-1-1**. The estimated cost for each of the capital upgrades includes a Capital Cost Contingency and a Project Delivery Allowance.

Table E-1-1: Implementation and Staging

Project ID	Project Description	MCEA Project Schedule	Priority Projects	Strategic Projects
			2027 to 2031	5 to 30-year
Highpoint Avenue	Capital Upgrades	Schedule 'A+'	$3,004,000	
Austin Drive	Capital Upgrades	Schedule 'A+'	$1,185,000	
Lodge Street	Capital Upgrades	Schedule 'A+'	$2,061,000	
Thorndale Drive & Westvale Drive	Reconfiguration of weir	Schedule 'A+'	$105,000	
Forwell Trunk Sewer	Allowance for Potential Upgrades	Further study required under the MCEA Schedule		$23,500,000

Frobisher Drive	Capital Upgrades	Schedule 'A+'	$690,000	
Union Street East	Capital Upgrades	Schedule 'A+'		$612,000
		Total	**$7,045,000**	**$24,112,000**

It should be noted that the Forwell trunk, under both current and future conditions, is subject to surcharge issues. Assumptions regarding growth and external contribution flows require close review to prevent exacerbation of these issues. If actual flows surpass initial assumptions, it could increase the risk of basement flooding. Therefore, continual monitoring and adjustment of these assumptions are essential for the long-term sustainability and efficiency of the Forwell trunk. This Master Plan focussed on capacity constraints, however, the condition of sewers such as the Forwell trunk should also be reviewed. The Forwell Trunk, has some sections which exhibit structural concerns. Accordingly, as part of the Master Plan, a contingency allowance will be established as noted in Table E-1-1 to address potential future replacement needs for portions of the Forwell Trunk.

This update to the Master Plan was conducted following the Municipal Class Environmental Assessment (Class EA) process for Master Plans, Approach 2, as outlined by the Municipal Engineers Association in June 2000 and subsequently amended in 2023.

Abbreviations

ADSF	Average Dry Weather Sewage Flow
DWF	Dry Weather Flow
DEM	Digital Elevation Model
EA	Environmental Assessment
EMP	Employment
FM	Flow Meter
FS	Flow Split
GIS	Geographic Information System
GWI	Groundwater Infiltration
HGL	Hydraulic Grade Line
HP	High Point
ICI	Industrial – Commercial – Institutional (Land Use)
IDF	Intensity – Duration - Frequency
I/I	Inflow/Infiltration
MH	Maintenance Hole
MP	Master Plan
O&M	Operation & Maintenance
PCSWMM	Personal Computer Storm Water Management Model (Software)
RDII	Rainfall-Derived Infiltration and Inflow
RES	Residential
RTK	RTK Unit Hydrograph Method
RG	Rain Gauge
SAN	Sanitary
SCADA	Supervisory Control and DATA Acquisition
SPS	Sewage Pumping Station
TN	Technical Note
WWF	Wet Weather Flow
WWTP	Wastewater Treatment Plant

1.0 INTRODUCTION

The City of Waterloo (City) has retained Stantec Consulting to complete the Waterloo Sanitary Servicing Master Plan Update (Master Plan Update). The purpose of the Master Plan Update is to revise the 2014 Sanitary Master Plan (Stantec, 2015) to account for updated infrastructure, and population and employment growth within the City.

There are two growth scenarios: the Priority Scenario, which includes population projections up to a 2031 planning horizon, and the Strategic Scenario, representing population projections up to a 2051 planning horizon. Priority and strategic projects will be evaluated to operate the system efficiently and effectively, to implement best management practices (including Infiltration/Inflow (I/I) reduction and mitigation programs, rainfall and flow monitoring and sanitary hydraulic model updates & maintenance), and to optimize staging of the sanitary capital program.

This update to the Master Plan was conducted following the Municipal Class Environmental Assessment (Class EA) process for Master Plans, Approach 2, as outlined by the Municipal Engineers Association in June 2000 and subsequently amended in 2023. The update of the Master Plan was carried out by completing seven significant tasks:

- **Task 1:** Model Infrastructure Updates; involves updating the existing infrastructure model with the latest data and information.
- **Task 2:** Model Flow Updates; involves updating the model with the latest provided data.
- **Task 3:** Model Calibration; involves adjusting the model parameters until the model outputs match observed data.
- **Task 4:** Model Analysis – Identification of Problem Areas; involves using the model to identify areas of the infrastructure that are problematic or could become problematic in the future.
- **Task 5:** Detailed Analysis of Solutions; involves using the model to evaluate different solutions to the identified problem areas.
- **Task 6:** Conclusions & Recommendations – Capital Planning and Execution; involves drawing conclusions from the analysis and making recommendations for capital planning and execution.
- **Task 7:** Finalize Master Plan Update; involves finalizing the Master Plan update based on the results of the previous tasks.

Each task is associated with specific Technical Notes (TN), present in **Appendix A** to **D**. The Master Plan primarily provides a technical overview, with in-depth details encapsulated within the respective TNs. The results from Tasks 1 to 4 were employed to update the current hydraulic model. This model was then used in Task 5 to identify constraints and develop alternative solutions to accommodate future growth. Within Task 6, these alternatives were assessed to identify the preferred alternatives and provide recommendations for implementation. The Final Report (Task 7) for the Master Plan is intended to

summarize the master planning process, the results of the tasks undertaken, and to highlight recommended priority and strategic projects. The Master Plan report is divided into seven (7) sections:

- **Section 1.0** introduces the project, outlines the study area and details the process and methodology used in the Master Plan Update, and provides an overview of the consultations with the public and agencies that took place during the Master Plan.
- **Section 2.0** offers background information on the Policy, planning and design documents reviewed during the Master Plan process.
- **Section 3.0** includes the Master Plan Update process and methodology, and an overview of the public and agency consultation which occurred throughout the Master Plan.
- **Section 4.0** provides a Study Area Inventory including population and growth projections, inter-municipal sewage flows, and a summary of natural, social and economic features.
- **Section 5.0** provides an overview of the model development process.
- **Section 6.0** provides an overview of the capacity analysis and needs assessment for growth development areas, and capacity constraints related to planned growth. This section also includes a summary of the evaluation of climate change scenarios, along with suggestions for the I/I program.
- **Section 7.0** presents a summary of recommendations for servicing strategies including proposed priority and strategic projects, including opinion of probable cost for the proposed priority and strategic projects, and implementation of projects.
- **Section 8.0** presents the conclusions and recommendations of the Master Plan.

1.1 STUDY AREA

The study area for this Master Plan is the City of Waterloo, within the city limits. The City limits are displayed on **Figure 1-1**.

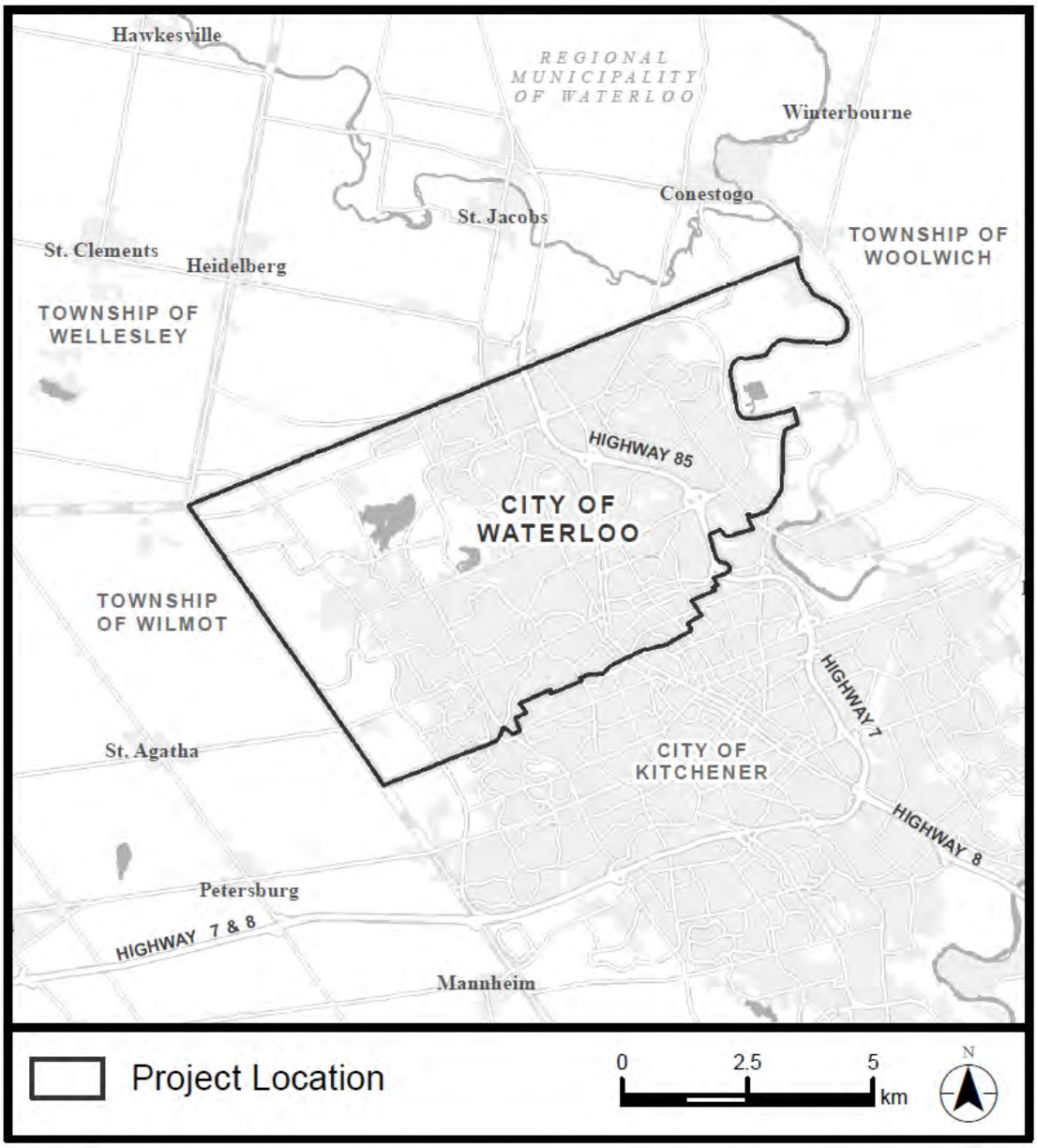


Figure 1-1: City of Waterloo City Limits

2.0 PROJECT BACKGROUND

2.1 SANITARY COLLECTION SYSTEM OVERVIEW

The sanitary collection system, is comprised of roughly 420 km of sanitary sewers, including local sewers, trunk sewers, and forcemains, along with six sewage pump stations (SPS). The system collects sewage and conveys it to the WWTP for treatment. The system also receives additional flows from outside the City boundaries, including parts of the Township of Woolwich and two sewage pumping stations located in the City of Kitchener. Figure 2-1 illustrates the City's sanitary collection system, SPS, forcemains, and external flow contributions. **Technical Note #1 and #2** provides further details about the collection system (see **Appendix A** and **B**).

In the process of updating the Master Plan, it is important to note that no modifications have been made to the Private Servicing Alternatives. For further details, please refer to Section 6.5.1 of the 2014 Master Plan.

2.2 DRIVERS FOR THE MASTER PLAN

The primary factors influencing the Master Plan Update are:

1. Need to identify up-to-date recommendations for priority and strategic projects to accommodate proposed growth up to the 2051 planning horizon.

2. The need to revise sanitary flow predictions based on the latest population projections for the City of Waterloo and contributing areas.

3. The requirement to update the understanding of Inflow and Infiltration (I/I) in the system, considering 2021 flow monitoring data, and system upgrades implemented since the 2014 Master Plan.

4. The development of an updated sanitary hydraulic modelling tool intended for long-term use in aiding decision-making and implementation planning.

LAUREL WTP
STOCKYARDS 1
FROBISHER SPS
NORTHLANDS SPS
STOCKYARDS 2
ST.JACOBS WWTP
MILLENIUM SPS
COLONIAL SPS
BEAVER CREEK SPS
MALABAR SPS
FALCONRIDGE SPS
BRIDGEPORT SPS
MOORE SPS
LANDFILL LEACHATE

BENJAMIN ROAD
ERBSVILLE ROAD
NORTHFIELD DRIVE WEST
NORTHFIELD DRIVE EAST
WEBER STREET NORTH
KING STREET NORTH
UNIVERSITY AVENUE EAST
SAWMILL ROAD
BEARINGER ROAD
LEXINGTON ROAD
COLUMBIA STREET WEST
FISCHER HALLMAN ROAD NORTH
BRIDGE STREET WEST
BLOOMINGDALE ROAD NORTH
EBY CREST ROAD
ERBS ROAD
ERB STREET WEST
ERB STREET EAST
BRIDGEPORT ROAD EAST
HIGHWAY 85
BRIDGE STREET EAST
VERMONT ROAD SOUTH
KING STREET SOUTH
WEBER STREET SOUTH
KING STREET WEST
LANCASTER STREET WEST
UNIVERSITY AVENUE WEST

Legend

- WWTP
- Storage
- Storage & Emergency Storage
- Overflow
- Forcemain
- Local Sewer
- Trunk Sewer
- External Contribution

Kitchener Drainage Areas

- Bridgeport Pump Station
- Falconridge Pump Station
- Moore Pump Station

0 500 1,000 metres

1:37,500 (At original document size of 11x17)

Stantec

Project Location
City of Waterloo

165640363 REVA
Prepared by HB on 2023-08-02

Client/Project
CITY OF WATERLOO
SANITARY MASTER PLAN

Figure No.
2-1

Title
Sanitary Sewer System

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Contains information provided by the City of Waterloo under licence.

2.3 BACKGROUND DOCUMENTS & REPORTS

The City of Waterloo provided various background documents and reports, which will be used throughout this Master Plan Update and are summarized in this section. The reports pertain to the following topics:

- Previous Master Plan
- Water Billing and land use
- Infrastructure master planning
- Flow monitoring
- Population updates & growth

Table 2-1 summarizes the background reports and documents that are relevant to the existing and future sanitary collection system for the Master Plan Update. All documents and reports from the previous Master Plan that are still relevant can be used but are not summarized in this table.

Table 2-1: Summary of Background Documents & Reports

	Source	Synopsis	Relevance
1	Waterloo Sanitary Master Plan (Stantec, 2015)	Previous Sanitary Master Plan.	Basis of update for the current Master Plan.
2	Sewage Pumping Station Information (City of Waterloo, 2022)	Detailed information on pump station design and operation (wet well volume, rated capacity, etc.).	Updating the sewage pumping stations in the model.
3	City of Waterloo Official Plan (City of Waterloo, 2022)	City planning information including land use, cultural heritage landscapes, sensitive environments, forest, wetlands, and zoning.	Context for growth, sewage flows, and alternative solution constraints.
4	2020 Data Quality Review (City of Waterloo, 2022)	A high-level data review of the rain gauge and the flow monitoring data (January 2020 to December 2020).	Provides input into the flow monitoring data review.
5	Major Intensification Projects (City of Waterloo, 2022)	Information on major intensification projects, identifying the site area, the number of units, the density, and the status.	Used to inform the development of population growth scenarios.
6	2021 Census Release 2 Information Report (City of Waterloo, 2021)	Findings from the second Census data release (age distribution, population change 2016 to 2021, proportion of single-detached houses, private households by household size).	The census data provides the 2021 populations which forms the basis of the Master Plan model update, and this report provides the key findings regarding demographics from the census data.

	Source	Synopsis	Relevance
7	Cross Border Agreement Information (City of Waterloo, 2022)	Specifics on inter-municipal agreements for sewage flow exchange across borders.	Validate/add boundary conditions representing the Cross Border data in the model.
8	Water Billing Information (City of Waterloo, 2022)	Spreadsheet with the water billing information per address and land use, in m^3 units.	To corroborate monitored per capita sewer flow generation rates and to distribute census populations by general land use.
9	Sanitary Scores Spreadsheet (City of Waterloo, 2022)	Asset management condition scoring of the conduits (score 1 to 5; assumed to be NASSCO).	Informs the understanding of the existing collection system condition and will factor into alternative solution development and Capital prioritization.
10	Flow Monitoring Data (City of Waterloo, 2022)	Temporary monitoring program data files (depth, velocity, calculated flow) in CSV format for years 2014 to 2021, and rainfall in CSV format for years 2020 and 2021.	Collection system characterization and supports model calibration.

2.4 POLICY, PLANNING AND DESIGN DOCUMENTS

A summary of the provincial and municipal planning and policy context is provided below as it relates to the Sanitary Master Plan.

2.4.1 Federal Legislation

2.4.1.1 Canadian Environmental Assessment Act

The *Canadian Environmental Assessment Act* (2012) focuses federal environmental review on projects which have the potential to cause significant adverse environmental effects in areas of federal jurisdiction. For the *Act* to apply, the proposed project must be designated under the “Regulations Designating Physical Activities” and specifically be listed in the “Schedule for Physical Activities”. Review of the Schedule for Physical Activities shows there is no physical activity that matches the work proposed. Therefore, meeting the requirements of the *Canadian Environmental Assessment Act* will not be necessary for this project.

2.4.1.2 Fisheries Act

The federal Fisheries Act (1985) is the primary legislation governing fish and fish habitat in Canada. The Fisheries Act defines fish habitat as “…waters frequented by fish and any other areas on which fish depend directly or indirectly in order to carry out their life processes including spawning grounds and nursery, rearing, food supply and migration areas.” The fish and fish habitat protection provisions of the Fisheries Act apply to all fish and fish habitat in Canada. The Act prohibits activities that result in the death of fish or the harmful alteration, disruption or destruction (HADD) of fish habitat unless authorized

by the Minister of Fisheries, Oceans and the Canadian Coast Guard. If it is determined that the death of fish or HADD of fish habitat is unavoidable as part of the Project, an authorization under the Fisheries Act may be required.

2.4.1.3 Species at Risk Act

The *Species at Risk Act* (SARA) identifies wildlife species considered to be at risk in Canada and designates them as threatened, endangered, extirpated or of special concern. Species at Risk (SAR) are identified and assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), which is an independent committee of wildlife experts and scientists that makes recommendations to the federal government regarding the status of wildlife species in Canada.

The purpose of SARA is to prevent wildlife species from being extirpated or becoming extinct, to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity and to manage species of special concern to prevent them from becoming endangered or threatened.

The protection and conservation measures afforded by SARA apply to those species identified on Schedule 1 of the *Act.* Other species identified by COSEWIC as SAR that required further assessment in accordance with current assessment criteria are identified on Schedule 2 (Endangered and Threatened) and Schedule 3 (Special Concern) of the *Act*. All listed (Schedule 1) aquatic species and migratory birds in Canada are protected by SARA. Remaining listed species (plants, mammals, reptiles, amphibians) are only protected where they occur on federal lands (i.e., National Parks, First Nations Reserves).

Any activity affecting a listed species, or its critical habitat requires the prior issuance of a permit from the applicable agency, either Environment and Climate Change Canada or Fisheries and Oceans Canada (DFO). Permits may only be issued for scientific research relating to the conservation of the species, where activities are required to benefit a species or to enhance its chances of survival or for incidental impacts. Efforts to avoid, reduce, or minimize impacts must first be employed and activities will not be permitted if they would jeopardize the survival or recovery of the species.

2.4.2 Provincial Policies and Legislation

2.4.2.1 The Planning Act

The *Planning Act, R.S.O. 1990, c.P13* sets the framework for land use planning in Ontario. According to the provisions within the Act, the Province of Ontario is the primary authority for planning matters in Ontario, and the *Act* enables the Province to delegate some of its planning authority to the upper-tier municipalities (i.e., counties and regional/district municipalities, and planning boards) while retaining control through the approval process. Municipalities must conform to approved policies of the Provincial government and its agencies. Provincial ministries, municipal councils, planners, and other stakeholders implement the *Act* when they undertake certain actions, including:

- Preparing Official Plans and planning policies that guide future development considering provincial interests, such as protecting and managing natural resources;

- Regulating and controlling land uses through zoning by-laws and minor variances; and
- Dividing land into separate lots for sale or development through Plans of Subdivision or a Land Severance.

This study considers development applications approved under the *Planning Act* and associated conditions of approval along with lands designated for future development within the City of Waterloo.

2.4.2.2 Provincial Policy Statement

The *Provincial Policy Statement* (PPS) (2020), issued under Section 3 of the *Planning Act*, sets a policy foundation for regulating the development and use of land. It provides direction on matters of provincial interest and supports the enhancement of the quality of life for all citizens of Ontario, while still maintaining environmental integrity. In accordance with Section 3 of the *Planning Act*, decisions affecting planning matters shall have regard for the PPS. The PPS establishes a framework to build strong communities while ensuring development patterns are efficient and optimize the use of land, resources, and public investment in infrastructure.

Policies relevant to water infrastructure include the requirement for infrastructure to be provided in a coordinated, efficient, and cost-effective manner that considers impacts from climate change while accommodating projected needs (Policy 1.6.1). These systems are meant to minimize erosion and changes in water balance and prepare for the impacts of a changing climate through the effective management of stormwater, including the use of green infrastructure (Policy 1.6.6). The service shall promote the efficient use and optimization of existing services, ensure the systems are reliable, promote efficiency, and integrate land use considerations throughout the process. The preferred alternatives and supporting recommendations will meet the objectives of the PPS by providing for infrastructure that is appropriate to address projected needs, protects the natural environment and protects public health and safety.

2.4.2.3 Endangered Species Act

The *Endangered Species Act* (ESA) (2007) identifies wildlife species considered to be at risk in Ontario and designates them as threatened, endangered, extirpated or of special concern. Provincial species at risk are identified and assessed by the Committee on the Status of Species at Risk in Ontario (COSSARO) which is a committee of wildlife experts and scientists, as well as those who provide Indigenous traditional knowledge, that classify species according to their degree of risk based on the best available scientific information, community knowledge and Indigenous traditional knowledge. When COSSARO classifies a species at risk, that classification applies throughout Ontario, unless otherwise noted.

The ESA protects species at risk and their habitats by prohibiting anyone from killing, harming, harassing or possessing protected species, as well as prohibiting any damage or destruction to the habitat of species identified on the Species at Risk in Ontario (SARO) list. Species listed as threatened or endangered on the SARO list are provided with general habitat protections under the *ESA*, which protect

areas that species depend on to carry out their life processes, such as reproduction, rearing, hibernation, migration, or feeding.

Activity that may impact a protected species or its habitat requires the prior issuance of a permit from the MECP. Such permits may only be issued under certain circumstances, which are limited to activities required to protect human health and safety, activities that will assist in the protection or recovery of the species, activities that will result in an overall benefit to the species or activities that may provide significant social or economic benefit without jeopardizing the survival or recovery of the species in Ontario.

A permit may be issued under Section 17(2) of the ESA or eligible activities can be registered under Ontario Regulation 242/08 to authorize work that is otherwise prohibited. Consultation with the ministry is recommended early in detailed design and prior to the works starting to ensure compliance with the ESA.

2.4.2.4 Climate Change

The MECP's guide, *Consideration of Climate Change in the Environmental Assessment Process*, outlines two approaches for considering and addressing climate change in project planning, including:

- Reducing a project's impact on climate change (climate change mitigation measures).
- Increasing the projects and the local ecosystem's resilience to climate change (climate change adaptation).

As part of this study, the objectives of the climate change document have been considered and incorporated into the generation and evaluation of alternatives and mitigation measures.

2.4.2.5 Grand River Conservation Authority

The *Conservation Authorities Act* (CAA) was created with the purpose of conservation, restoration, development, and management of natural resources in watersheds in Ontario. The CAA is now administered by the Ministry of the Environment, Conservation and Parks (MECP). The Ministry of Natural Resources and Forestry (MNRF) is responsible for conservation authorities' activities related to natural hazard management. Conservation Authorities are enabled with regulatory responsibility within their respective jurisdictions. The Grand River Conservation Authority (GRCA) is the CAA regulatory agency for the study area.

Under Ontario Regulation 150/06, GRCA reviews projects and implements their permitting process to achieve the following under the CAA:

- Prevent the loss of life and property due to flooding and erosion.
- Prevent pollution.
- Conserve and enhance natural resources.

The regulation applied to fill placement and removal or site grading, flood prone areas, erosion prone areas, dynamic beach areas, alteration of watercourses, and interference with wetlands.

2.4.3 Municipal Planning Policies

2.4.3.1 Region of Waterloo Official Plan

The Region of Waterloo Official Plan (2015) directs growth and change towards a more balanced community structure. The Region of Waterloo is an upper tier municipal government, and includes the Cities of Cambridge, Kitchener, and Waterloo, and the Townships of North Dumfries, Wellesley, Wilmot, and Woolwich. The Region is committed to a sustainable community, by providing infrastructure services that support a diverse and growing economy that develop the Region is a sustainable manner.

The Official Plan notes the Region will prepare and update a Regional Wastewater Treatment Master Plan to provide direction for planning and staging of investments in the Region's wastewater treatment plants and facilities. The plan will guide the operation of the Region's day-to-day wastewater treatment programs and protect human health and the natural environment.

2.4.3.2 Region of Waterloo Wastewater Treatment Master Plan

The Region of Waterloo Wastewater Treatment Master Plan (2018) provides strategic long-term planning for the Region's wastewater treatment services. The goal of the plan is to develop a comprehensive, cost-effective and feasible strategy to address wastewater treatment needs for a 35-year horizon.

The Region owns wastewater treatment plants, wastewater residuals processing facilities, wastewater pumping stations, and wastewater collection systems, treating approximately 66 million cubic meters of wastewater annually. Most of the collection systems and pumping station infrastructure that conveys wastewater to the Region's treatment facilities are owned, managed and operated by the area municipalities (Cities of Cambridge, Kitchener, Waterloo and Townships of Wilmot, Woolwich). The Wastewater Treatment Master Plan identifies projects, new technologies, and servicing strategies to meet long term needs of residents and businesses within the Region.

2.4.3.3 City of Waterloo Official Plan

The City of Waterloo Official Plan (2022) outlines a framework for land use decision-making for the City, representing the vision for growth and change within the community. The Plan supports the overall goal of achieving a healthy community built on the principles of diversity and adaptability, accessibility and equity, connectivity, health and vitality. The City is committed to providing sustainable infrastructure, while minimizing disturbance to and protecting the natural environment.

3.0 MASTER PLAN UPDATE METHODOLOGY

3.1 PROJECT ORGANIZATION

In the Master Plan Update, the City Project Team oversaw technical aspects and project management, collaborating with the Consultant Team. They attended meetings, transferred City data to the Consultant Team, and provided guidance on technical models and public consultation materials. They also managed advertisements for Master Plan Notices and updated the City website.

The Consultant Team, maintaining regular communication with the Project Team Project Manager, conducted research, analysis, model development, flow monitoring analysis, and reporting. They prepared draft stakeholder lists, notices, advertisements, and public consultation materials for City review and distributed the Notices to the Stakeholder list. The project organization is depicted in **Figure 3-1**.

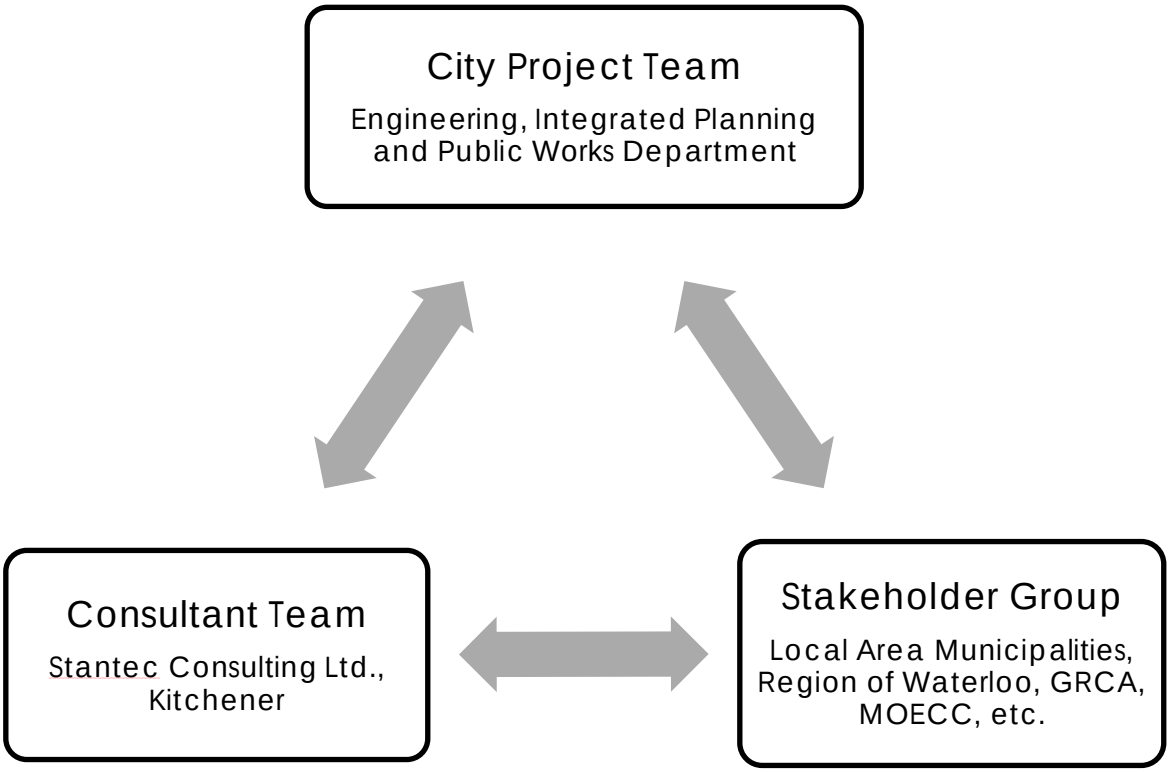


Figure 3-1: Project Organization

3.2 MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT PROCESS

The Environmental Assessment Act of Ontario (EAA) provides for the protection, conservation, and management of the environment in Ontario. Activities with common characteristics and common potential effects may be assessed as part of a "class" and are therefore approved subject to compliance with the pre-approved Class EA process. The Ministry of the Environment, Conservation and Parks (MECP) is responsible for administration of the EA Act.

The Municipal Class Environmental Assessment (MCEA) is an approved Class EA process that applies to municipal infrastructure projects including roads, water, and wastewater. This process provides a comprehensive planning approach to consider alternative solutions and evaluate their impacts on a set of criteria (e.g., environmental, social, technical and economic considerations) and determine mitigating measures to arrive at a preferred alternative for addressing the problem (or opportunity). The Class EA process involves a rigorous public consultation component that includes various provincial and municipal agencies, Indigenous communities, and the public, at each of the project stages.

The MCEA process is undertaken prior to modifications or additions to municipal infrastructure, to ensure that potential impacts associated with all project aspects are considered. **Figure 3-2** illustrates the Class EA planning process and identifies the steps considered mandatory for compliance with the requirements of the EA Act. The following provides an overview of the five-phase planning process:

- **Phase 1** – Identify the Problem and Opportunity statement
- **Phase 2** – Identify and evaluate alternative solutions
- **Phase 3** – Identify and evaluate alternative design concepts for the preferred solution
- **Phase 4** – Prepare design plans and an Environmental Study Report (ESR) for a minimum 30-day public review period
- **Phase 5** –This phase involves detailed design, and the preparation of contract/tender documents followed by construction, operation, and monitoring.

The EA process adhered to for this study and shown in **Figure 3-2** follows the MCEA document amended in 2015. Despite further amendments to the MCEA process in 2023, this study was conducted under the 2015 guidelines in place at the project's inception. As such, it was undertaken as a Schedule B project under Approach 2. However, it's important to note that the recommended projects will ultimately be classified as 'exempt' under Schedule A+.

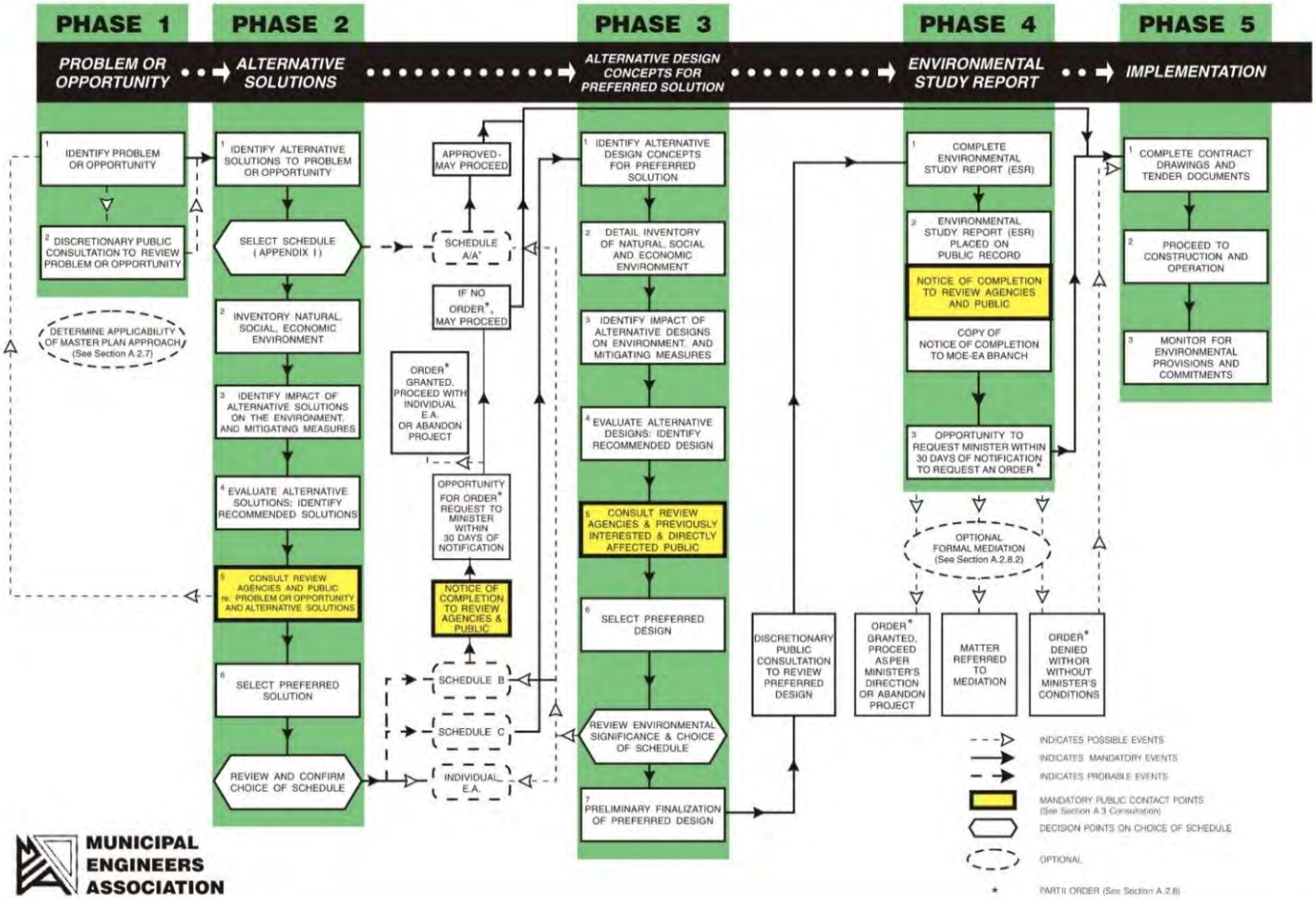


Figure 3-2: Municipal Class Environmental Assessment Process

Based on the nature and extent of the project, as well as its anticipated impacts to the surrounding environment, the MCEA document specifies different schedules under which projects may be planned, and the assessment process required for each:

Schedule A/A+ projects are pre-approved under the MCEA and can proceed directly to Phase 5 (implementation). Schedule A and A+ projects, include various municipal maintenance, operational activities, rehabilitation works, minor reconstruction or replacement of existing facilities, and new facilities that are limited in scale and have minimal adverse effects on the environment. These projects are exempt from the requirements of the *Environmental Assessment Act*.

Schedule B projects have potential for some adverse environmental impacts. These projects are required to proceed through the first two phases of the MCEA process, involving mandatory contact with directly affected public and relevant review agencies, to ensure that they are aware of the project and that their concerns are identified and considered. A Project File Report must be prepared and made available for review (30-day public review period) by any interested person or party. If there are no outstanding concerns or Section 16 Orders, then the proponent may proceed to implementation/detailed design (i.e., Phase 5) once the regulatory process has been completed. Schedule B projects generally include improvements and minor expansions to existing facilities or smaller new projects.

Schedule C projects have the potential for more significant environmental impacts. These projects are required to proceed through all five stages of the MCEA process. Schedule C projects require an Environmental Study Report be completed and filed for a 30-day public review period. If there are no outstanding concerns, the proponent may proceed to implementation once the regulatory process has been completed. These projects generally include the construction of new facilities, or major expansions to existing facilities.

The selection of the appropriate project schedule to be followed is dependent on the anticipated level of environmental impact, and at times the estimated construction costs.

The MEA Class EA document also identifies different approaches to completing Master Plans corresponding to different levels of assessment. Regardless of the approach selected, Master Plans must follow at least the first two phases of the MCEA process.

Approach 1 is undertaken with a broad scope and level of assessment. This process follows Phases 1 and 2 as defined above, then uses the Master Plan as a basis for future investigations of site-specific Schedule ‘B’ and ‘C’ projects. Any Schedule ‘B’ and ‘C’ projects that need specific Phase 2 work and Phases 3 and 4 work, usually have this Phase 2, 3, and 4 deferred until the actual project is implemented.

Approach 2 is undertaken to complete all work necessary for Schedule ‘B’ site-specific projects at the time they are identified. Using this approach, a municipality would identify everything it needed in the first five years and would complete all the site-specific work required, including public consultation to meet Class EA requirements. The Master Plan in such cases has to be completed with sufficient detail so that the public can be reasonably informed, and so that the approving government Agencies (Conservation Authorities, MECP, MCM, etc.) can be satisfied, in principal, that their concerns will be addressed before construction commences.

Approach 3 is to complete the requirements of Schedule 'B' and Schedule 'C' at the Master Plan stage. The Master Plan would document Phases 1 to 4 of the Class EA process.

3.2.1 Class EA Project Classification

This Master Plan is being undertaken in accordance with Approach #2 of the Master Planning Process, as outlined in Appendix 4 of the Municipal Class EA document (2015). Master plans are long range plans which integrate infrastructure requirements for existing and future land use with environmental assessment planning principles. These plans examine an infrastructure system(s) or group of related projects in order to outline a framework for planning for subsequent projects and/or developments. This report is intended to fulfill the requirements of Schedule B projects which may be identified through the Master Planning process.

3.2.2 Section 16 Order Process

Interested persons may provide written comments to the City of Waterloo for a response using the following contact information:

Veronica Kroess
Project Manager
City of Waterloo
Veronica.Kroess@waterloo.ca
519-886-2310 ext. 78563

In addition, a request may be made to the Minister of the Environment, Conservation and Parks under Section 16 of the *Environmental Assessment Act* requiring a higher level of study (i.e., requiring an individual/comprehensive EA approval before being able to proceed), or that conditions be imposed (e.g., require further studies), only on the grounds that the requested order may prevent, mitigate, or remedy adverse impacts on constitutionally protected Aboriginal and treaty rights. Requests on other grounds will not be considered. Requests should include the full name and contact information of the person(s) making the request for the ministry.

Requests should specify what kind of order is being requested (request for additional conditions or a request for an individual/comprehensive environmental assessment), how an order may prevent, mitigate, or remedy those potential adverse impacts, and any information in support of the statements in the request. This will ensure that the ministry is able to efficiently begin reviewing the request.

The request should be sent in writing by mail or by email to:

Minister of the Environment, Conservation and Parks
Ministry of Environment, Conservation and Parks
777 Bay Street, 5th Floor
Toronto ON M7A 2J3
minister.mecp@ontario.ca

and

Director, Environmental Assessment Branch
Ministry of Environment, Conservation and Parks
135 St. Clair Ave. W, 1st Floor
Toronto ON, M4V 1P5
EABDirector@ontario.ca

Requests should also be sent to the City.

3.3 TECHNICAL NOTES

In the Master Plan development, seven Technical Notes (TN) were created. Each note is briefly described below. Key meetings with the project team and stakeholders were held to gather information, including data from neighbouring Municipalities and the Region on current and future external flows to the City's collection system.

Technical Note 1, satisfies Task 1 of the Master Plan, documents the review and validation of data for the sanitary system model and GIS data enhancement. This includes incorporating physical attributes essential for hydraulic modelling and data related to surface area for model loading. The data review, conducted in GIS using ESRI ArcMap and hydraulic modelling software PCSWMM, includes a gap assessment and data confidence evaluation for model application. Technical Note 1, found in **Appendix A**, details this process.

Technical Note 2-3 effectively completed Tasks 2 and 3. Task 2 involved updating the model with the most recent data provided. This process ensured that the model's inputs were current and accurate, reflecting the latest changes in infrastructure and population. Task 3, on the other hand, focused on the calibration of the model. This involved fine-tuning the model parameters to ensure that the model's outputs accurately matched the observed data. This rigorous calibration process is crucial in enhancing the reliability and accuracy of the model's predictions and insights. These tasks collectively contribute to the robustness of the model, ensuring it remains a valuable tool for decision-making and strategic planning. The process is elaborated in Technical Note 2, which can be found in **Appendix B**.

Technical Note 4 satisfies Task 4 of the Master Plan, which involves using the model to pinpoint areas of the infrastructure that are currently problematic or could potentially become problematic in the future. This task encompasses the creation and application of the hydraulic model for evaluating both existing and future conditions. TN4 also provides a summary of the methodology used for system performance assessment and the procedures for future model updates. The key findings of Technical Note 4 are documented in **Section 6.0** and the complete Technical Note 4 can be found in **Appendix C**.

Technical Note 5-6 addresses two tasks of the Master Plan. The first task involves using the model to evaluate various solutions for identified problem areas within the infrastructure, which is crucial in determining effective strategies for addressing these issues. The second task involves deriving conclusions from the conducted analysis and formulating recommendations for capital planning and execution, ensuring that the findings from the analysis are effectively translated into actionable plans for infrastructure improvement and development. Refer to **Appendix D** for details on Technical Note 5-6.

3.4 CONSULTATION

Consultation is a vital part of the Class EA process. Active engagement with all potentially affected parties including government agencies, community members, special interest groups, and Indigenous communities ensures a transparent and responsible planning process.

3.4.1 Project Contact List

A project contact list was created which includes multi-level government agencies and officials, City of Waterloo staff, committees, emergency service contacts, potentially interested Indigenous Communities, members of the public, utility services, special interest groups, as well as local property owners within the study area. The list was regularly updated to include those who expressed interest in the study. Addresses for all properties within the study area were compiled and used for the mail out of the initial Notice of Study Commencement. A copy of the contact list is provided in **Appendix E.**

3.4.2 Project Notices

Notices were sent via mail or email (where requested) to property owners within the study area, the project contact list, and Indigenous communities. Notices were published in the Waterloo Chronicle and Waterloo Record newspapers. The notice was also posted on the City's website (https://www.engagewr.ca/sanitary-master-plan). The study notifications are provided in **Appendix F**, including:

- Notice of Study Commencement – published on the City of Waterloo website on August 10, 2022. Mailed and emailed to the project contact list, Indigenous communities, and property owners on August 10, 2022. Published in the Waterloo Chronicle and Waterloo Record on August 18, 2022.
- Notice of Public Information Centre 1 – published on the City of Waterloo website on September 7, 2022. The notice was mailed and emailed to the project contact list, Indigenous communities, and property owners on September 14, 2022. Published in the Waterloo Chronicle and Waterloo Record on September 8 and 15, 2022.
- Notice of Public Information Centre 2 – published on the City of Waterloo website on September 6, 2023. The notice was mailed and emailed to the project contact list, Indigenous communities, and property owners on July 7, 2023. Published in the Waterloo Chronicle and Waterloo Record on September 14 and 21, 2023.
- Notice of Study Completion – will be published in the Waterloo Record, and mailed and emailed to the contact list, Indigenous communities, and property owners.

3.4.3 Public Consultation

Two Online Public Consultation Centres (PCCs) were hosted on the City's website (https://www.engagewr.ca/sanitary-master-plan) as a component of the consultation process for this project to provide the public with an opportunity to express concerns throughout the study process, while assisting the development of a preferred plan.

3.4.3.1 Online Public Consultation Centre 1

The first Online PCC was hosted on the City's website from September 15 to October 12, 2022. The purpose of the PCC was to present background information on the study, evaluation criteria, and next steps. A pre-recorded presentation was provided online.

Interested persons were able to submit comments through the City's website or provide directly to a member of the project team by phone or email. No comments were received.

The PCC presentation and transcript are provided in **Appendix E**.

3.4.3.2 Online Public Consultation Centre 2

The second Online PCC was hosted on the City's website from September 14 to October 16, 2023. The purpose of the PCC was to present the evaluation process, preferred strategy, and next steps of the study. A pre-recorded presentation was provided online.

Interested persons were able to submit comments through the City's website or provide directly to a member of the project team by phone or email. One comment was received.

The PCC presentation and transcript are provided in **Appendix E**.

3.4.4 Agency and Stakeholder Consultation

The notices were sent to relevant agencies and stakeholders to solicit feedback on the project. A list of the agencies and stakeholders is provided below.

Provincial/Federal

- Ministry of Natural Resources and Forestry
- Ministry of Environment, Conservation and Parks
- Ministry of Citizenship and Multiculturalism
- Ministry of Transportation
- Ministry of Agriculture, Food, and Rural Affairs
- Ministry of Indigenous Relations and Reconciliation
- Department of Fisheries and Oceans Canada
- Infrastructure Ontario
- Ontario Clean Water Agency (OCWA)

Municipal

- City of Waterloo
- Region of Waterloo
- Township of Wilmot
- Township of Woolwich

Agencies

- Grand River Conservation Authority
- Hydro One
- Waterloo North Hydro
- Enbridge
- Rogers Cable
- Bell Canada
- Canadian Pacific Railway
- Canadian National Railway
- Waterloo Catholic District School Board
- Waterloo District School Board
- Waterloo Regional Police Service
- Region of Waterloo Paramedic Health and Emergency Services
- Waterloo Fire Rescue
- Greater KW Chamber of Commerce
- Waterloo Region Nature
- Region of Waterloo Heritage Planning Advisory Committee
- Waterloo Region Home Builders Association
- City of Waterloo Committees

A copy of agency correspondence is provided in **Appendix E**.

3.4.5 Indigenous Consultation

Notices were sent with a cover letter to the following Indigenous communities:

- Six Nations of the Grand River
- Haudenosaunee Confederacy Chiefs Council
- Mississaugas of the Credit First Nation

The City of Waterloo was responsible for the correspondence with Indigenous communities throughout the duration of the study. Correspondence was issued by email to the aforementioned Indigenous communities for the Notice of Study Commencement, Notice of PCC #1, and Notice of PCC #2. The City will provide the Notice of Completion to the Indigenous communities. A copy of Indigenous communities' correspondence is provided in **Appendix E**.

3.4.6 Notice Of Study Completion - And 30-Day Review Process

The 30-day review period is an important element of the Schedule B process. It offers an opportunity for all stakeholders to examine the study's findings and provide their input. This aligns with the protocols established under the previous Class Environmental Assessment (Class EA) process.

The study is being presented to the council with the objective of obtaining approval for the Notice of Study Completion and the initiation of the 30-day review period. Stakeholder participation and feedback are highly valued and contribute significantly to the project's success.

4.0 STUDY AREA INVENTORY

The updated Master Plan aims to identify required infrastructure enhancements to support the forecasted population growth until 2051. Population projections have been established for two planning horizons; 2031 and 2051, with potential infrastructure upgrades factored into these scenarios according to projected timelines.

The plan includes recommendations for Priority Projects, slated for 2027 to 2031, and Strategic Projects for 2051, both of which align with the respective planning scenarios.

4.1 POPULATION ESTIMATIONS

4.1.1 Existing Population

The 2021 census data, provided in shapefile format. The residential population estimates, based on the 2021 Census data, show a total of 121,436 people in Waterloo. Additionally, the transient student and employment populations are based on the City of Waterloo population projections (City of Waterloo; Hemson Consulting Ltd. Development Charges Background Study 2020; Statistics Canada, Census of Canada 2016), which are 18,083 and 72,125, respectively. The model takes into account the population from Kitchener contributing to the Waterloo sewer system, while excluding the Waterloo population serviced by Kitchener's system. This results in a total existing population of 201,771 considered in the model.

4.1.2 Future Population

For the 2031 and 2051 horizons, the City has provided growth polygons in a shapefile format. Taking into account these growth polygons, the model includes a total population of about 237,450 for the 2031 horizon, encompassing residential, student, and employment equivalents. For the 2051 horizon, the model includes a total population of around 265,000, again including residential, student, and employment equivalents. **Table 4-1** present the existing population, along with the projected populations for 2031 and 2051, as considered in each scenario.

Table 4-1: Existing Population (2021) and Projected Population Growth

Scenario	Population Growth	Total Population
Existing (2021)[1]	0	201,771
Projected Growth to 2031	35,679	237,450
Projected Growth to 2051	27,550	265,000
Note: 1- Existing population includes population from Kitchener to Waterloo sewer system, and excludes population from Waterloo connected to Kitchener sewer system		

4.2 INTER-MUNICIPAL SERVICING AGREEMENTS

The sanitary network receives inflows from various external sources beyond the City's boundaries. **Figure 2-1** illustrates these external contributions, which include the following sources:

- Inflows from the St. Jacob's Farmers Market and Stockyards area
- Inflows from the Falconridge Pump Station (PS)
- Inflows from the Bridgeport Pump Station (PS)

These inflows have been integrated into the sanitary hydraulic model. A more comprehensive discussion on these flows can be found in **Section 6.5.5**.

4.3 NATURAL, SOCIAL, AND ECONOMIC FEATURES

As part of the study, the existing natural, social, and economic features were taken into consideration when evaluating the alternatives to identify preferred solutions. A desktop inventory was completed for natural, social features, and economic contributions.

4.3.1 Natural Features Overview

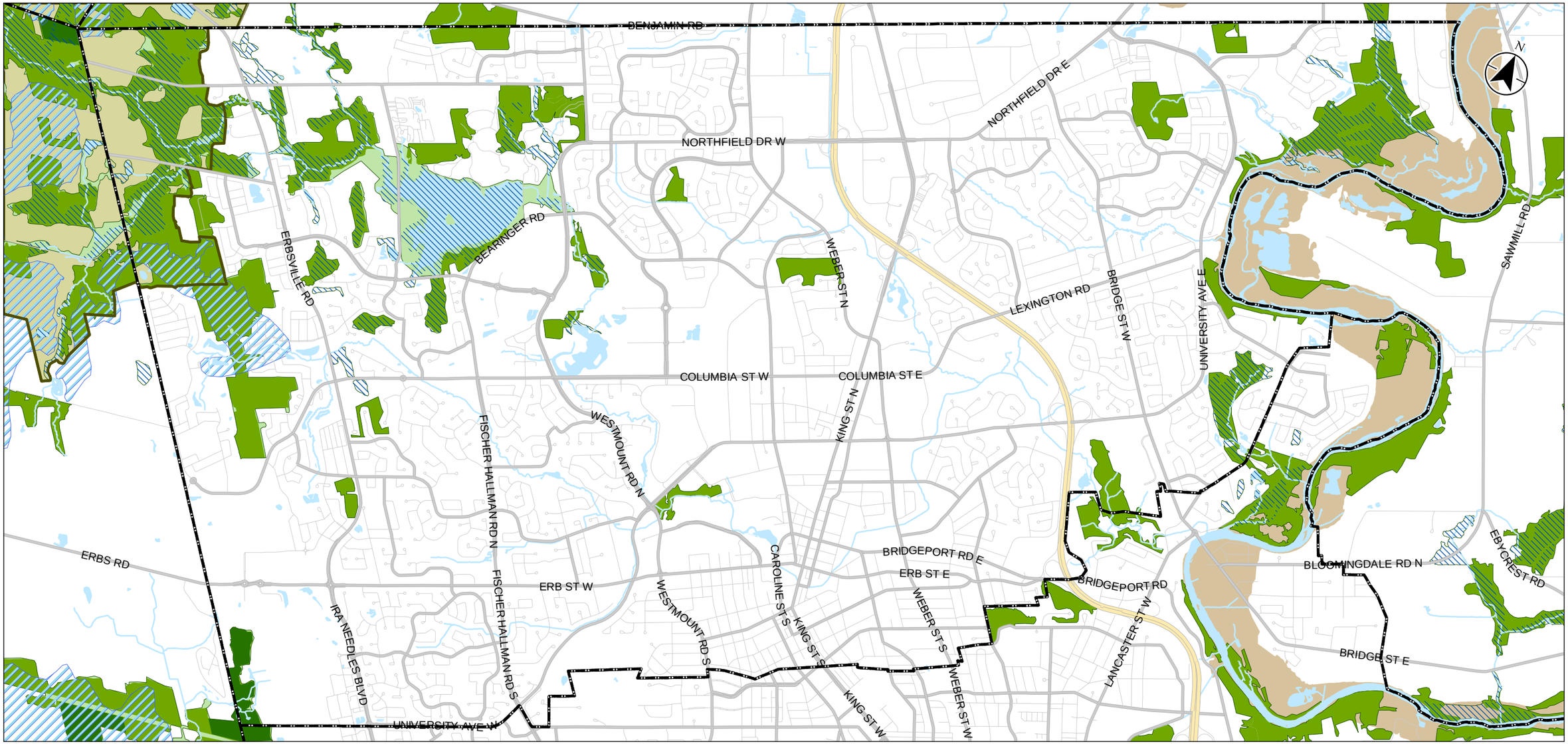
Natural features identified for consideration in the evaluation process included: waterbodies, watercourses, regional recharge areas, significant valleys, wetlands, regional forests, forest greater than 4 ha, and environmentally sensitive policy areas. **Figure 4-1** provides a map of the natural features identified within the City. As the City progresses these improvements, these natural features will be considered.

4.3.2 Social Features

Social features identified for consideration in the evaluation process included: regional cycling routes, historical streets, heritage buildings, heritage districts, cultural heritage landscapes, and significant buildings in the City. **Figure 4-2** provides a map of the natural features identified within the City. As the City progresses these improvements, these social features will be considered.

4.3.3 Economic Contributions

Economic features identified for consideration in the evaluation process included: major transit station areas, primary nodes, major/minor nodes, major/minor corridors. **Figure 4-3** provides a map of the natural features identified within the City. As the City progresses these improvements, these economic features will be considered.



Legend

- Watercourse
- Waterbody

Landscape Level Systems

- Regional Recharge Area
- Significant Valley
- ROP15_EnvSensitiveLandscapes

Core Environmental Features

- Wetland
- Regional Forest
- Forest Greater Than 4 ha
- Environmentally Sensitive Policy Area

0 500 1,000 metres

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Stantec

Project Location
City of Waterloo

165640366 REVA
Prepared by KDB on 2024-01-12

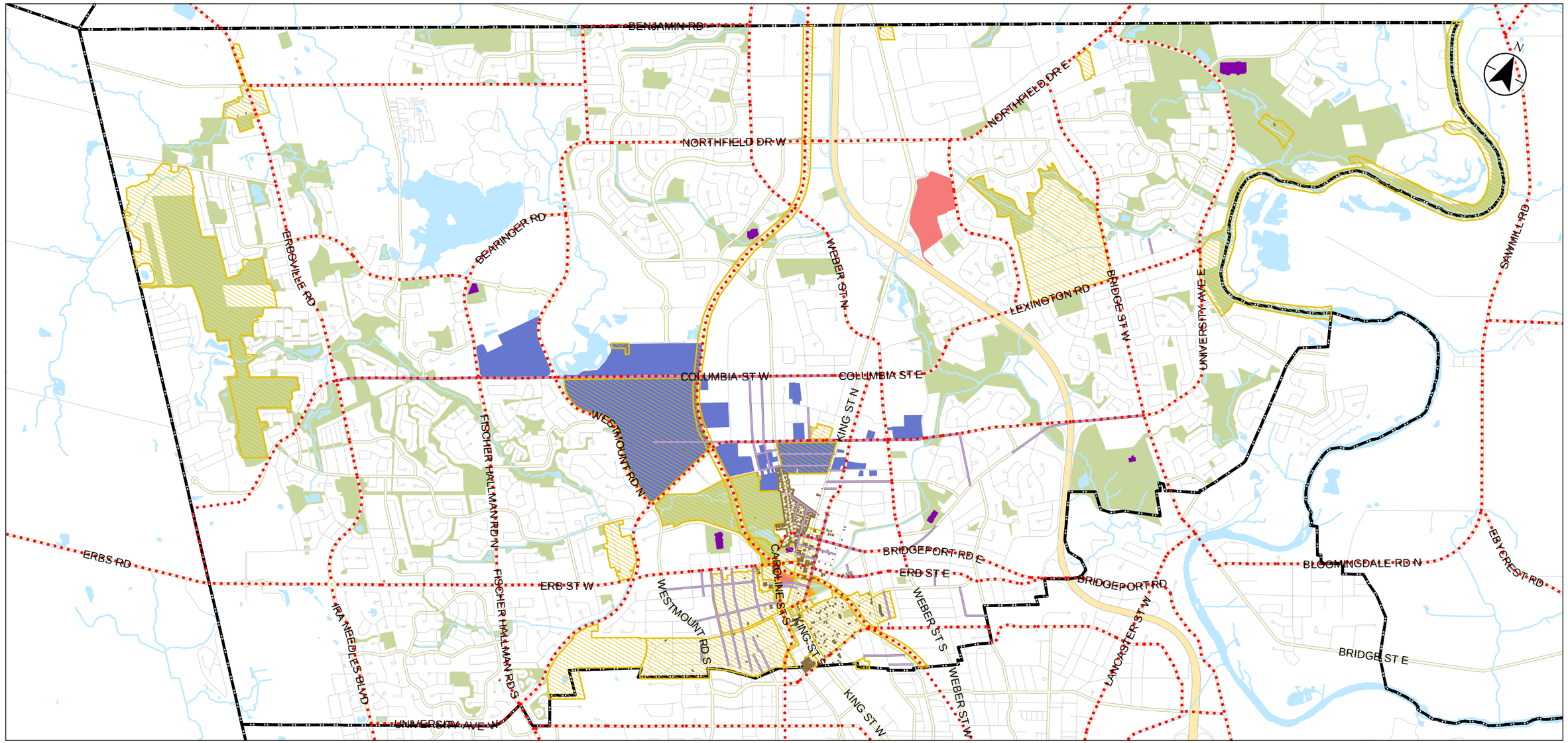
Client/Project
CITY OF WATERLOO
SANITARY MASTER PLAN

Figure No.
4-1

Title
Natural Features

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Contains information provided by the City of Waterloo under licence.

V:\01656\active\165640383\GIS\mxd\SocioEconomic\165640383_NaturalFeatures.mxd Revised: 2024-01-12 By: kebuchanan



Legend

- Regional Cycling Route
- Historical Street
- Heritage Building
- Heritage District
- Cultural Heritage Landscapes
- City Hall
- Community Centre or Library
- Shopping Centre
- University or College
- Park

0 500 1,000 metres

1:37,500 (At original document size of 11x17)

Stantec

Project Location
City of Waterloo

165640366 REVA
Prepared by KDB on 2024-01-15

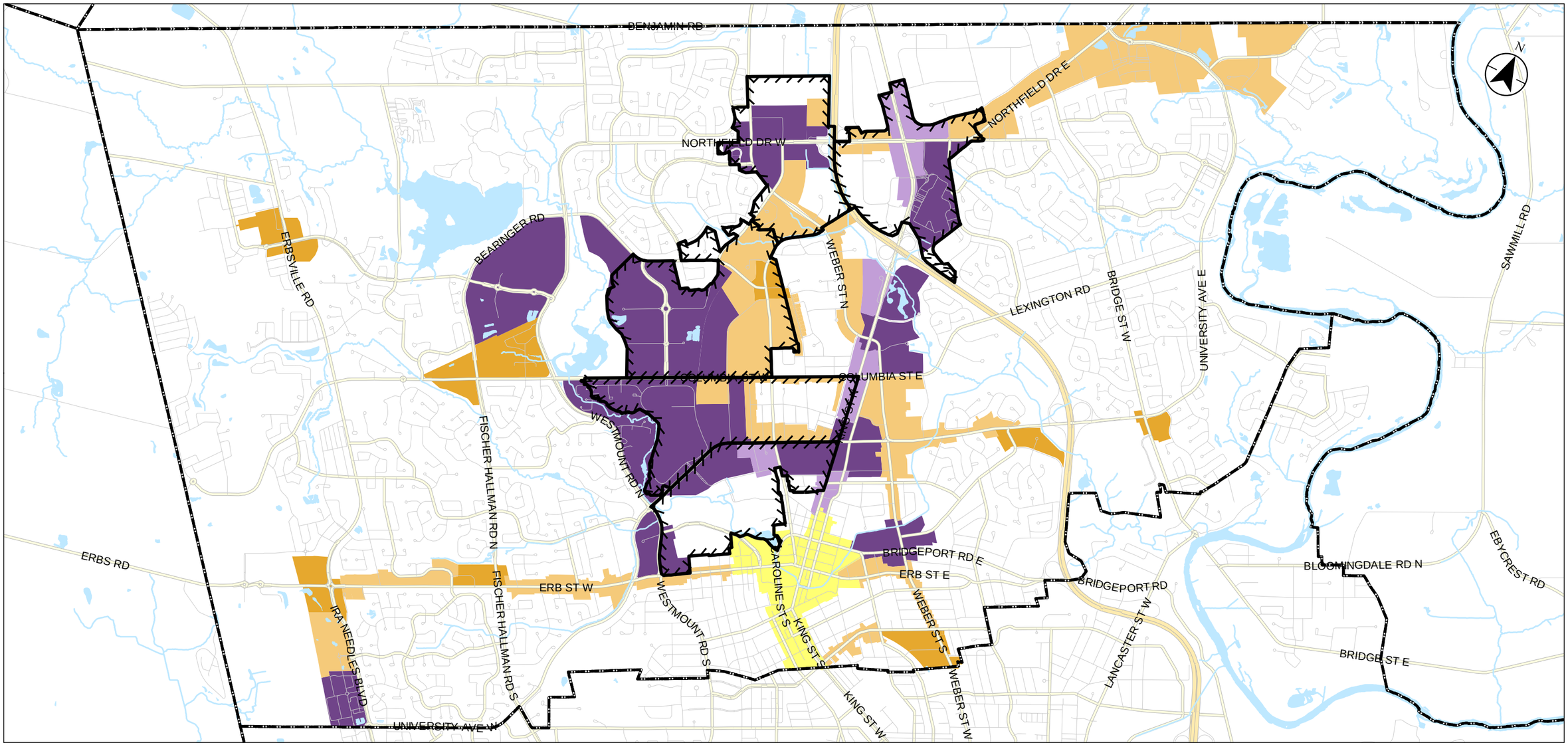
Client/Project
CITY OF WATERLOO
SANITARY MASTER PLAN

Figure No.
4-**2**

Title
Social Features

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Contains information provided by the City of Waterloo under licence.

V:\01656\active\165640366\GIS\mxd\SocioEconomic\165640366_SocialFeatures.mxd Revised: 2024-01-15 By: kdbuchanan



Legend

- Major Transit Station Area
- Primary Node
- Major Node
- Minor Node
- Major Corridor
- Minor Corridor

0 500 1,000 metres

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Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
2. Contains information provided by the City of Waterloo under licence.

Stantec

Project Location
City of Waterloo

165640366 REVA
Prepared by KDB on 2024-01-12

Client/Project
CITY OF WATERLOO
SANITARY MASTER PLAN

Figure No.
4-**3**

Title
Economic Contributions

5.0 HYDRAULIC MODEL DEVELOPMENT

5.1 PCSWMM MODEL

The PCSWMM model, a comprehensive tool for modelling wastewater, was employed in this study. This model is particularly effective due to its ability to integrate both hydrology and hydraulics components.

Infrastructure data forms the backbone of the PCSWMM model. This includes information about the physical characteristics of the stormwater network, such as pipe diameters, lengths, slopes, and manhole elevations. Refer to **TN1** for details on the model network updates.

The hydrology component of the PCSWMM model allows for the simulation of rainfall-runoff processes at a catchment scale. The hydraulics component, on the other hand, simulates the flow of water through the sanitary network, including pipes, and pumping stations. These flows include residential flows, which are calculated based on population density and industrial/commercial/institutional (ICI) flows, which are estimated based on the type and size of the establishments.

For a more detailed on the PCSWMM model and its application in this study, refer to **TN#2-3** and the calibration appendix.

5.2 2021 FLOW METER

The PCSWMM model, a tool for modelling wastewater, was employed to track the areas contributing to water flow and to create a diagram. This diagram, shown in **Figure 5-1**, illustrates the 2021 flow meters and how they are connected, and **Figure 5-2** present the metershed area as well as the location of the rain gauge. Flow monitoring was conducted using 7 flow meters from 2014 to 2018, and an additional 8 flow meters were installed from January 2021 to December 2021. The data collected from the 2021 flow meters was use for the calibration of the sanitary model, in conjunction with the corresponding rain gauge data. This approach ensures a comprehensive understanding of the impact of rainfall on wastewater flow.

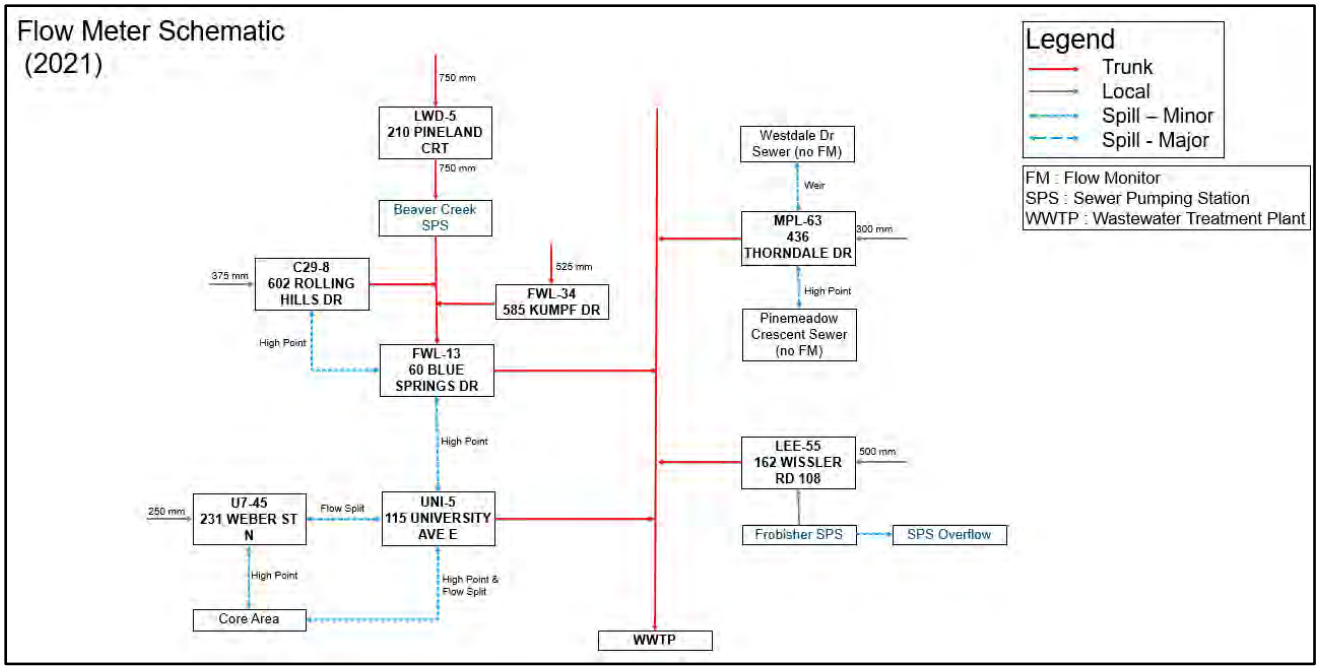


Figure 5-1: 2021 Flow Meter Schematic

Flow meters are sometimes set up in a series. In such a setup, sanitary water flows from one meter to the next. For instance, meters C29-8, FWL-34, and LWD-5 all flow into FWL-13, and meter U7-45 flows into UNI-5.

In some areas, the pipes split into two or more (a situation known as bifurcation). These splits can affect how water flows between different parts of the system. The diagram shows places where water could spill over from one area to another. This can affect the amount of water coming from upstream of flow monitors.

It's important to note that the data used to understand how the pipes connect and how deep they are (invert data) is based on a model that uses geographic information. There might be some errors in this data at the local level (see **Section 5.4** in **TN2-3** for more details).

Calibration is a key step to ensure the model's precision. To calibrate the model, the population data (how many people live in each metershed area) and flow monitor data (how much wastewater is flowing through the system) are used to determine the average sanitary flow. The model is then run for different periods and its output is compared with the actual observed data. If the model's results don't match the observed data, adjustments are made. These adjustments could involve changing the estimated amount of wastewater produced per person, or how that amount varies throughout the day. This process of running the model, comparing its outputs to observed data, and adjusting its parameters is repeated until the model's outputs closely match the observed data. At this point, the model is said to be calibrated. This ensures that the model accurately represents the real-world system.

In addition to the 8 flow meters from 2021, the sanitary flow at the Parshall Flume, which is upstream of the wastewater treatment plant, was measured. This data was used to validate that the model accurately represents the flow of the entire sanitary system.

5.3 AVERAGE SANITARY FLOWS

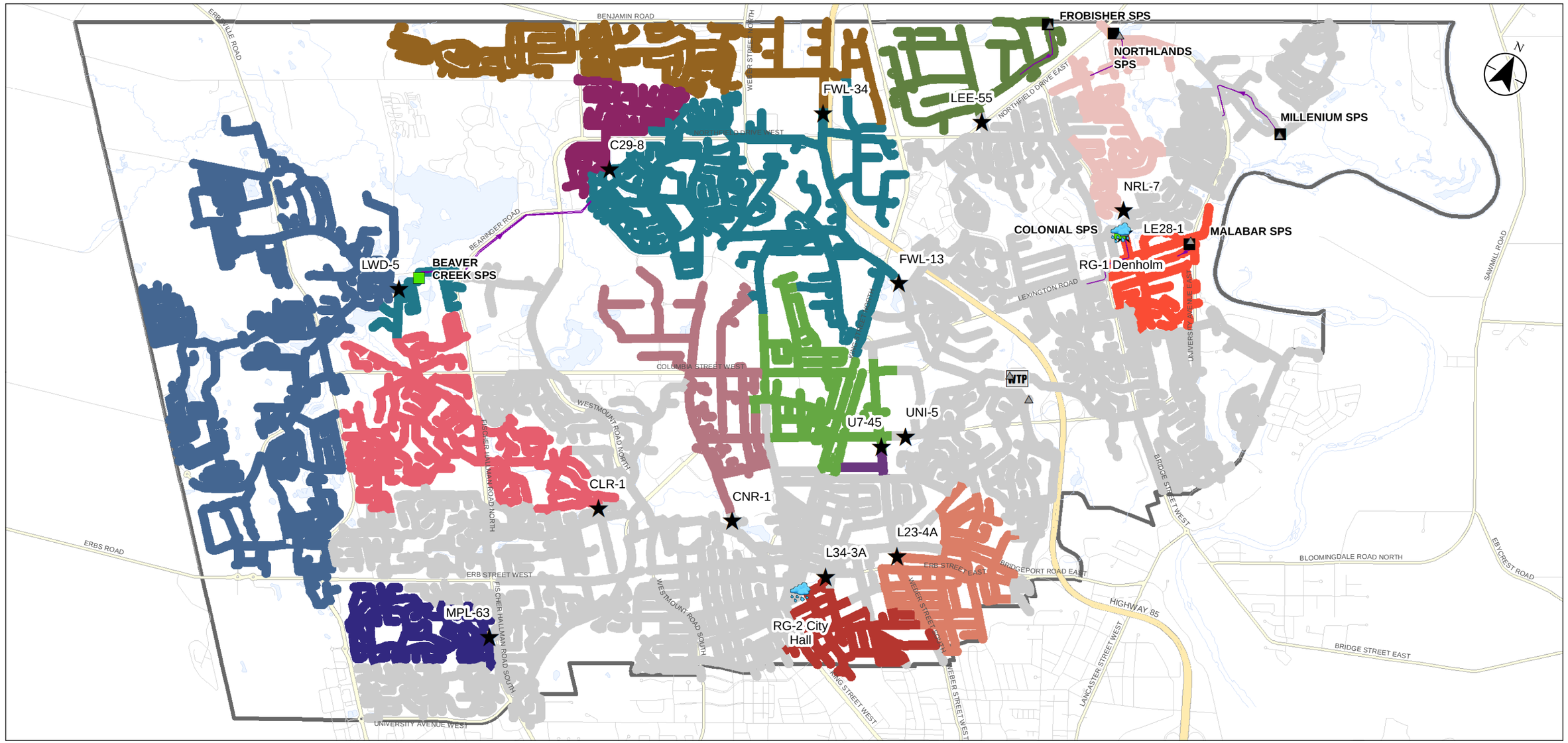
Sanitary loads, or the volume of wastewater entering the sanitary sewer system, are calculated based on the population in both residential and commercial areas within each section of the sanitary system. This calculation does not include groundwater infiltration (GWI). The average volume of wastewater produced per person per day is determined using data from flow monitors, and this rate is applied to the population contributing to each receiving pipe in the sanitary sewer system.

Sanitary flows are not constant; they fluctuate throughout the day. This fluctuation is represented in the model by a daily pattern, which is unique for each area of the system (metershed), based on flow monitor data. Because water usage varies between weekdays and weekends, two separate patterns are established for each tributary area and applied in the model to generate the sanitary load. Refer to **Technical Note #2-3** for details on average sanitary flows and the dry weather flow calibration.

5.4 GROUNDWATER INFILTRATION

Groundwater infiltration (GWI) occurs when water from the ground seeps into the pipe system. This can happen through leaky joints or cracks in the pipes. The volume of water entering the system (the GWI rate) is measured for each area using flow monitoring data.

This GWI rate is then adjusted based on the size of the area being monitored (sewershed). This adjustment results in a rate in liters per second per hectare (L/s/ha), which is applied to each sewershed. For areas that were not covered by the 2021 monitors, the GWI rates from the 2014 Master Plan model were used and applied to the updated areas. For more information on GWI, see **Technical Note #2-3**.



Legend

- WWTP
- Storage
- Storage & Emergency Storage
- Overflow
- Forcemain
- Flow Monitor
- Rain Gauge

2021 Metershed

- C29-8
- FWL-13
- FWL-34
- LEE-55
- LWD-5
- MPL-63
- U7-45
- UNI-5
- Unmonitored

2018 Metershed

- CLR-1
- CNR-1
- L23-4A
- L34-3A
- LE28-1
- NRL-7

0 500 1,000 metres

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Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
2. Contains information provided by the City of Waterloo under licence.

Stantec

Project Location
City of Waterloo

165640363 REVA
Prepared by HB on 2023-07-24

Client/Project
CITY OF WATERLOO
SANITARY MASTER PLAN

Figure No.
5-2

Title
2018 & 2021 Flow Monitoring Program with Rain Gauge Locations

5.5 WET WEATHER FLOWS

When it rains, water can enter the sanitary system through direct connections like downspouts, sump pumps, and foundation drains (this is called inflow), or by seeping into the system from the surrounding soil through cracks in the pipes (this is called infiltration). This is known as rainfall-derived infiltration and inflow (RDII). Refer to **Technical Note #2-3** for details on wet weather flow calibration.

5.6 INTER-MUNICIPAL SERVICING AGREEMENTS

5.6.1 Leachate Inputs

The Waste Management Site in the Region of Waterloo collects and pumps leachate into the City's Sanitary Network via Ira Needles Blvd. As per the existing agreement between the City and the Region, the discharge is limited to a peak flow rate of 15.2 L/s of leachate into the City's Network.

5.6.2 External Contributions

As per the 2014 Master Plan, the external contributions beyond the City's municipal boundary were added as inflow in the model. External contributions include the following:

- Region of Waterloo Landfill Leachate Pump Discharge
- Township of Woolwich St. Jacobs Market Area Discharge and Stockyards
- City of Kitchener Sanitary Pump Stations
- City of Kitchener residents serviced by the Waterloo system

The Waterloo Master Plan model includes several inflow and discharge points from adjacent systems, with six inflow locations identified based on system reviews. Four areas within Kitchener contribute to Waterloo's sanitary sewer system, integrated into the model using population estimates and a design rate of 3.5 persons per unit. Two pumping stations in Kitchener also contribute to the sewer system in Waterloo. The forcemain outflow from these stations is incorporated into the model as an inflow that varies over time. The model also includes the anticipated flow from the decommissioning of Moore SPS. The external contributions are detailed in **Table 5-1**, and refer to **Figure 2-1** for their location.

Table 5-1: External Contributions

Location (Sewershed)	Second Party in Cross Border Agreement	Scenario	Value Applied
350 Conservation Drive (Laurel WTP)	Woolwich	Future	9.00 L/s
Stockyards 1[1]	Woolwich	Existing & Future	Existing: 0.87 L/s 2031: 17.3 L/s 2051: 21.5 L/s
Stockyards 2[1]	Woolwich	Existing & Future	Existing: 2.12 L/s 2031: 30.3 L/s 2051: 37.8 L/s
St. Jacob	Woolwich	Future	2031: 55.0 L/s 2051: 66.2 L/s
Falconridge SPS	Kitchener	Existing & Future	SPS Outflow
Bridgeport SPS	Kitchener	Existing & Future	SPS Outflow
Moore St	Kitchener	Future	SPS Outflow
Margaret Ave	Kitchener	Existing & Future	7 Units x 3.5 PPU
Herbert St	Kitchener	Existing & Future	12 Units x 3.5 PPU
Silvercrest Drive	Kitchener	Existing & Future	1 Unit x 3.5 PPU
Esson St	Kitchener	Existing & Future	29 Units x 3.5 PPU

Note:
1- Existing flow is an average from flow monitoring data provided by the Township of Woolwich.

6.0 CAPACITY ASSESSMENT

6.1 DESIGN STORM EVENTS

The 3-hour Chicago storm events were used in the 2014 Master Plan to provide conservative results and allow a degree of comparison to the historic work completed for previous MP.

The “Chicago distribution” is a design hyetograph that describes the pattern of rainfall intensity during the storm event. The term “3-hour” refers to the duration of the storm event, which is a period of intense rainfall lasting three hours.

In the context of the Master Plan, these 3-hour Chicago storm events were used to generate conservative results, to assess the sanitary sewer system. Storm events expected to occur on a 10-year and 25-year frequency were chosen for capacity assessments. These assessments evaluate the ability of the sanitary system to handle these intense rainfall events.

Additionally, considering the trend of increasing storm intensity due to climate change impacts, a stress-test was performed on the system using the 25-year, 3-hour Chicago storm event, with an increase of 20% in rainfall intensity. This helps to understand how the system would perform under future conditions where storm events could be more intense due to climate change. While climate change-induced rainfall patterns, such as intense microbursts, could exacerbate surface flooding and the infiltration/inflow (I/I) issue, these micro-events fall beyond the purview of this study. Nevertheless, the implementation of enhanced grading standards and designs, the use of watertight maintenance lids, and the improvement of stormwater management under the City’s Climate Adaptation Equity policy are expected to mitigate such impacts.

Table 6-1 present an overview of the differences between the 2014 MP and the Update MP assessment for the design storm events.

Table 6-1: Overview of Design Storm Events

Master Plan	Design Storm Events
2014 MP	All Scenarios: 10-yr, 3-hour Chicago Distribution design storm; 25-yr, 3-hour Chicago event reviewed as a stress-test on the system.
MP Update	Pumping Station Assessment: 10-yr, 3-hour Chicago Distribution design storm; Sewer System Assessment: 25-yr, 3-hour Chicago event and 25-yr + CC, 3-hour Chicago event reviewed as a stress-test on the system.

6.2 LEVEL OF SERVICE CRITERIA - SEWERS

The target level of service is based on the capacity in the collection system and to ensure that the sewer system can handle the flow without causing basement flooding.

For dry weather flow (DWF) analysis, the ratio of maximum depth versus full depth (d/D) is used to identify capacity constraints. This ratio considered the fullness of the sewer pipes. If a pipe is 80% full depth or more, it is considered at capacity and requires attention. Moreover, as an assessment of operational issues, the peak DWF velocity is also assessed and compared to MECP Design Guidelines for the minimum scour velocity of 0.6 m/s.

During wet weather flow (WWF) events, it is acceptable for the sewer pipes to fill up completely as long as the water level remains at least 1.8 meters below the ground. This elevation represents approximately the depth of a typical basement, so any increase could risk basement flooding. Exceptions exist, such as large sewer pipes in ravines that do not connect to houses, but these are handled on a case-by-case basis.

Figure 6-1 illustrates the targeted level-of-service for WWF events in relation to the sewer water elevation and typical basement elevations.

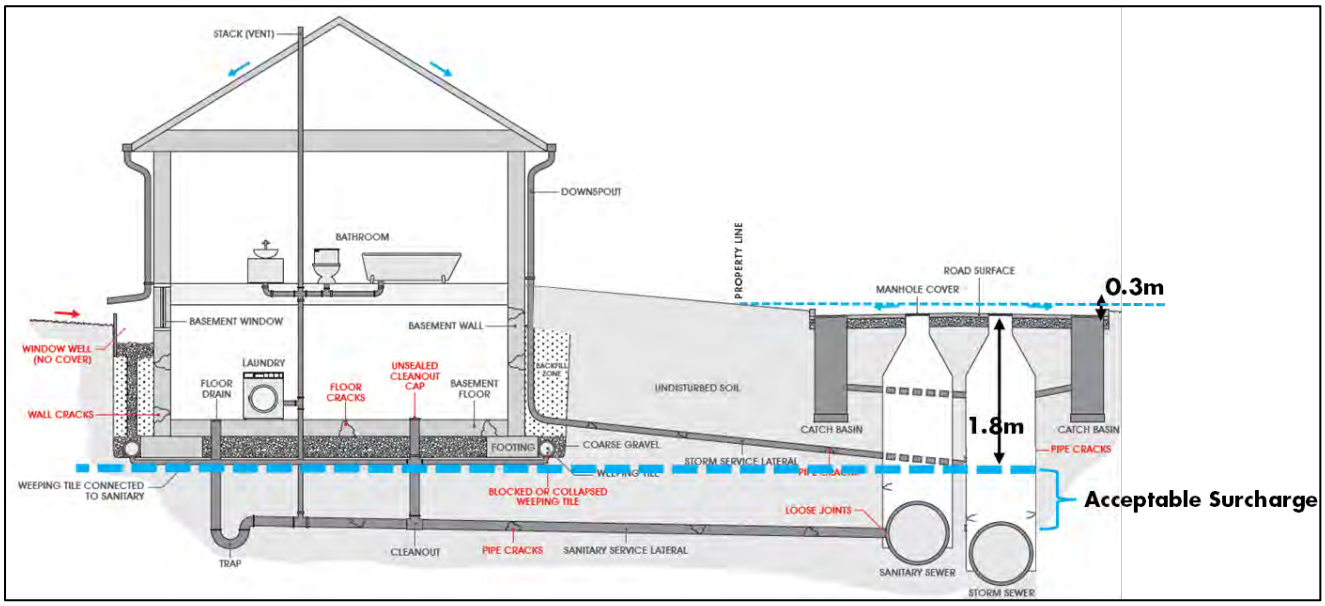


Figure 6-1: Definition of Flooding in Separated Sewer Systems

6.3 LEVEL OF SERVICE CRITERIA – PUMP STATIONS

The pumping station assessment consists of comparing the incoming peak flow during the 10-Year design event to the pumping station's firm capacity to identify the need for upgrades. The firm capacity of a pumping station is defined as the maximum pumping capacity with the largest pump offline.

The firm capacity was obtained for each pumping station from pump curves based on pump serial number on plate. The operation of the pumps (number of duty and standby pumps) informed the firm capacity used in this analysis. While the current operating capacity of the pumps may be lower than the theoretical capacities due to deteriorating conditions, it is assumed that the theoretical capacity will be achieved through planned maintenance.

6.4 EXISTING CONDITIONS

Existing conditions modelling scenarios represent 2021 populations and infrastructure, which includes infrastructure updates completed since the calibration period in Summer/Fall of 2021 and presented in TN#1. These populations were used during the calibration of the model and in the derivation of the calibrated per capita flow rates used in DWF generation, as presented in TN#2-3.

6.4.1 Sewer System Assessment

Table 6-2 presents the results of the peak inflow at the pumping stations for the 10-year design storm event under the existing conditions.

Table 6-2: Existing Conditions Pumping Stations Results

Pumping Station	10yr Incoming Peak Flow (L/s)	ECA Capacity (L/s)	Firm Capacity (L/s)
Beaver Creek	290.9	370.0	550.0
Colonial[1]	257.5	372.0	540.0*
Frobisher	20.3	35.0	60.0
Malabar	4.8	7.4	6.2
Millenium	28.6	86.0	152.0
Northlands	9.1	57.0	90.0

Note:

1- Firm capacity at Colonial SPS is estimated based on adding 2 duty pump capacities, i.e., does not consider reduction in capacity associated to two or more simultaneously running pumps

From this analysis, we can conclude that there are no capacity issues at the pumping stations under the conditions simulated in the model. The modelling results for the sewer system indicate that there are no capacity constraints leading to HGL issues under DWF conditions, however, during the 25-year design storm event, seven (7) problem areas have been identified. These existing problem areas are detailed in **Table 6-3** and **Figure 6-2**.

Table 6-3: Existing Conditions Sanitary Sewer Problem Areas

Problem Area ID	Location	Capacity Constraint Description
PA-1 Cedar Highpoint Ave	Highpoint Ave, between Northfield Dr W and Northlake Dr	HGLs within 1.8 m of surface due to undersized pipes. High risk of basement flooding and risk of surface flooding.
PA-2 University Austin Dr	From the intersection of Albert St and Cardill Crescent to the intersection of Austin Dr and Holly St	Risk of basement flooding (HGLs within 1.8 m of surface) and surface flooding due to undersized pipes along Austin Dr.
PA-3 Laurel 2 Lodge St / Weber	From Lodge St to the intersection of Weber St N and University Ave E	Risk of basement and surface flooding due to undersized pipes on Lodge St and Weber St N
PA-4 Maple Hill Maple Hill Creek	From the weir at Thorndale/Westvale to Roosevelt Ave	Risk of basement flooding (HGLs within 1.8 m of surface) due to undersized pipes on private property.
PA-5 Laurel 2 Weber St N	Weber St N, at the intersection of Hickory St E	Surcharging pipes upstream of shallow pipes resulting of an HGL within 1.8 m of surface. Low risk of basement flooding as it is an ICI area.
PA-6 Forwell Trunk Conestoga College	From Lexington Rd to the WWTP	HGLs within 1.8 m of surface due to undersized pipes and shallow pipes. Low risk of basement flooding as no building connection is anticipated along these sewers.
PA-7 Lee 1 Downstream of Frobisher SPS	Sewers directly downstream of Frobisher forcemain	Capacity constraints in DWF conditions due to undersized pipes, but no risk of basement flooding.

6.5 FUTURE CONDITIONS

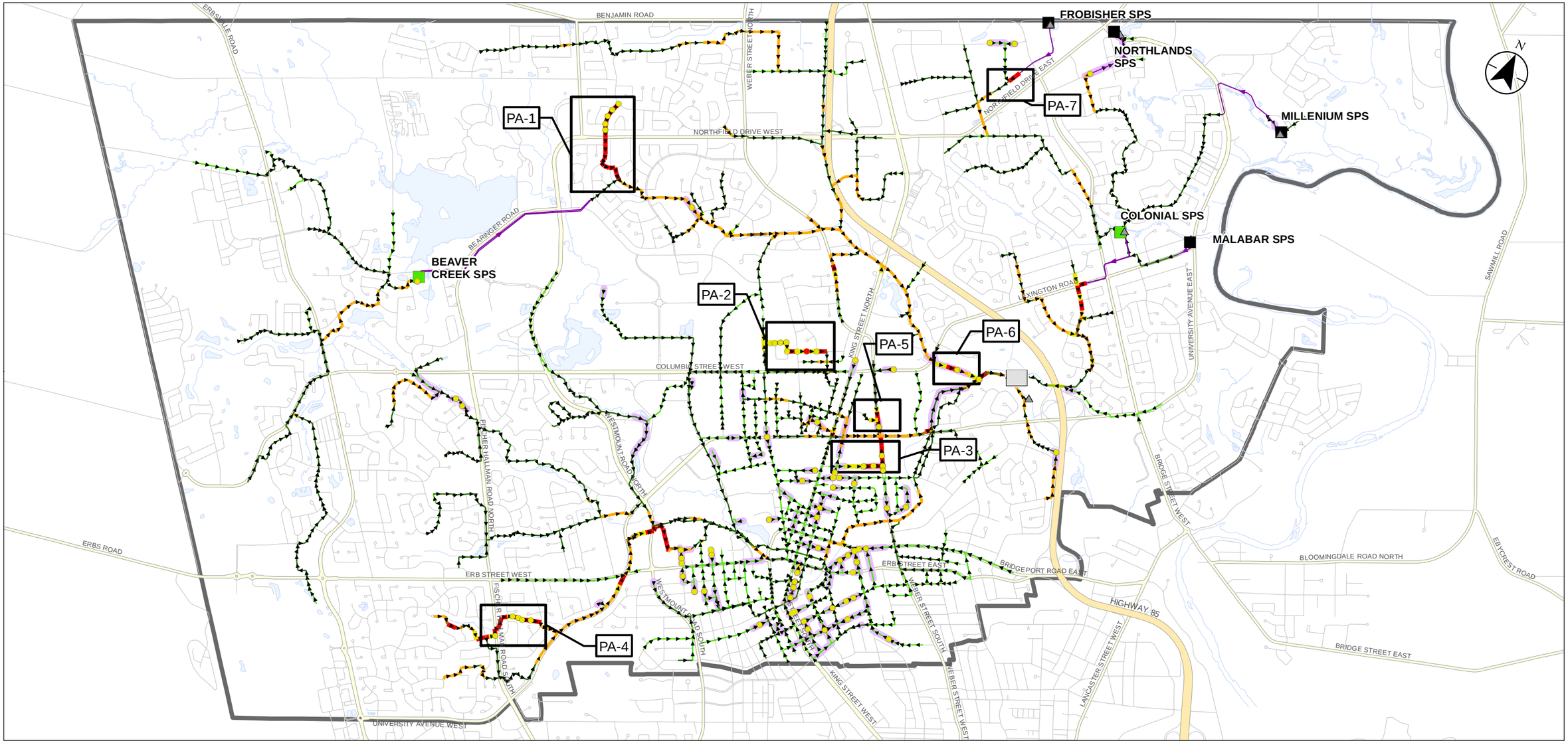
As outlined in **Technical Note #1**, this Master Plan Update has evaluated two growth horizons: 2031 and 2051. The subsequent sections provide an overview of the methodology used for the analysis and the outcomes of the capacity assessment.

6.5.1 Infrastructure Updates

For the growth horizons of 2031 and 2051, the assessment will be based on the existing infrastructure, which includes the sewer systems and pump stations. The City has not outlined any capital projects for the Master Plan Update.

6.5.2 Modelling Approach

Growth is anticipated to occur as infill, intensification, and new developments. The modelling approach for the sewage flow is to consider a per capita rate of 275 L/cap/day for both residential and ICI growth, as per the DGSSMS, and to apply the diurnal patterns from model calibration based on the sewershed receiving flows from the proposed development. The modelling approach for the wet weather flow for the two types of growth are discussed in the following sub-sections. **Figure 6-3** presents the new development and the external contributions.



Legend

- WWTP
- Storage
- Storage & Emergency Storage
- Overflow
- Forcemain
- Shallow Sewer

HGL Freeboard

- At or Above Surface
- Within Basement Level (Within 1.8 m of Surface)

Pipe Surcharge State

- Backwater Conditions
- Bottleneck Conditions (Undersized Sewer)

Free-Flowing Conditions

- 0% - 20%
- 20% - 50%
- 50% - 80%
- 80% - 99%

0 500 1,000 metres

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Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
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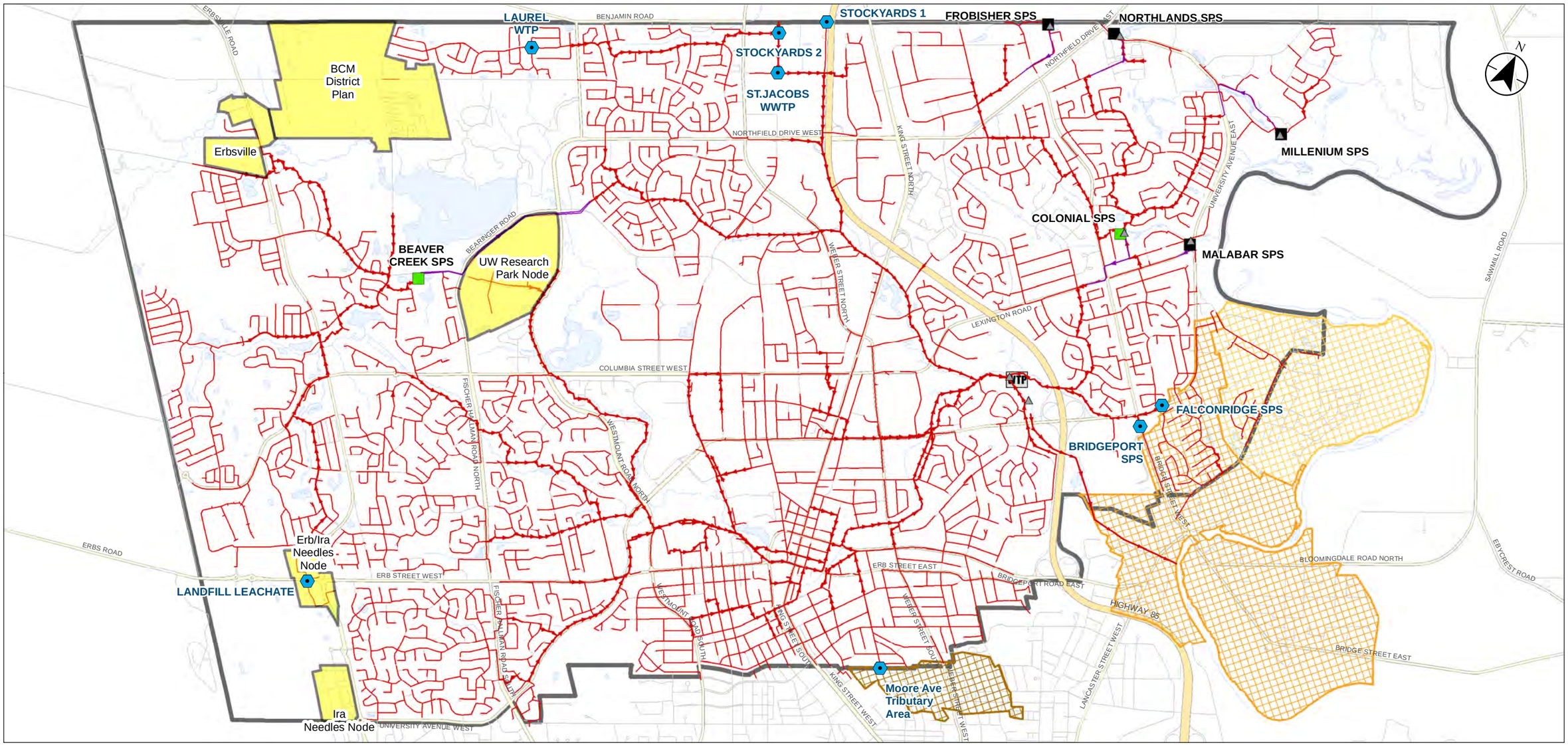
Figure No.
6-2

Title
Existing Conditions Sanitary Sewer System
25-Year HGL & Surcharge Results



Legend

- WWTP
- Storage
- Storage & Emergency Storage
- Overflow
- Forcemain
- Local Sewer
- Trunk Sewer
- New Development
- External Contribution

Kitchener Drainage Areas

- Bridgeport Pump Station
- Falconridge Pump Station
- Moore Pump Station

0 500 1,000 metres

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Figure No.
6-3

Title
New Development and External Contributions

6.5.3 Infill & Intensification

Within urban environments, infill is described as the redevelopment of land, and commonly includes the conversion of open space to new residential or ICI construction. Intensification includes the redevelopment of properties to accommodate higher densities of populations. Because the adjacent properties are often previously serviced by nearby municipal sanitary sewers, infill and intensification typically does not require additional City-owned infrastructure (i.e., only requires internal site servicing). For this reason, GWI and RDII parameters are already accounted for and do not require adjustments for infill development. Only population is adjusted per planning horizon for identified infill & intensification properties.

6.5.4 New Developments

Differing from infill, new developments are generally situated in undeveloped areas within the study area and often require new City-owned sanitary infrastructure for servicing. Population for these new developments are used to generate the average flow. Area-based contributions (GWI and RDII) are included in the node near new developments as they are not previously accounted for by surrounding subcatchments. In accordance with the 2014 Master Plan, an inflow and infiltration allowance of 0.15 L/s/ha was factored in to account for wet weather flows for new developments. This calculation was based on the assumption that the total area of the parcel is equivalent to the contributing area. Despite the updated Design Guidelines and Supplemental Specifications for Municipal Services (DGSSMS) recommending a rate of 0.25 L/s/ha for inflow and infiltration allowance, a rate of 0.15 L/s/ha was deemed suitable for new developments. This less conservative value is justified by the lower risk of inflow and infiltration associated with new and uncompromised infrastructure. The **Table 6-4** presents the growth polygons considered as new development for the future scenarios.

Table 6-4: New Development

Horizon	Name	Area (ha)	Extraneous Flows (L/s)	Population
2031	Erbsville	29.6	4.4	2,000
2031	BCM District Plan	157.4	23.6	7,500
2051	UW Research Park	73.4	11.0	50
2051	Ira Needles	17.7	2.7	200
2051	Erb/Ira Needles	19.0	2.9	150

6.5.5 External Contributions

There is identified growth in the external tributary that are outside the City's boundaries. The external contributions are presented in this Section.

6.5.5.1 Stockyards

Information regarding the Stockyards Area growth was obtained from the Master Servicing and Stormwater Management Report (SCS Consulting Group Ltd, 2020) on the Woolwich Township website. The growth areas provided in the report was assumed to be for the 2031 scenario. The future sanitary inflow was determined with the following design criteria:

- Retail: 0.50 L/s/ha
- Hotel: 225 L/bed/d (with 2 beds/room)
- Restaurant: 0.95 L/s/ha
- Peak Factor:
  - Hotel = Harmon Peaking Factor
  - Retail / Restaurant = 2.5
- Extraneous Flows: 0.25 L/s/ha
- For 2051 scenario, assumed a growth intensification of 25% from 2031 Scenario

Table 6-5 present the design flows for Stockyards area added as constant inflow in the future scenarios.

Table 6-5: Design Flows for Stockyards Area

Horizon	Model Node	Peak Flow (L/s)	Extraneous Flow (L/s)	Total Inflow (L/s)
2031	MH 15639 (F38-4B)	25.6	4.8	30.3
	MH 11908 (FWL-47)	13.9	3.4	17.3
2051	MH 15639 (F38-4B)	31.9	5.9	37.8
	MH 11908 (FWL-47)	17.3	4.2	21.5

6.5.5.2 Conservation Drive

Based on discussion with the City, the assumed Laurel Water Treatment Plant peak flow was added as a constant inflow of 9 L/s to MH 7519 (F78-33), as assessed by Jacobs Consulting. This addition to the model is conservative, as the agreement between the City and the Laurel Water Treatment Plant stipulates that the peak flow of 9 L/s is introduced into the system exclusively during off-peak hours.

6.5.5.3 Village of St. Jacobs

The 2018 Wastewater Treatment Master Plan (CIMA, 2018) recommended to convert the St Jacobs WWTP to a pumping station and divert flow to the Waterloo WWTP for treatment. **Table 6-6** presents the projected peak flow from St Jacobs WWTP which is assumed to be applied at MH 11904 (FWL-43) as per the 2014 Master Plan.

Table 6-6: Peak Inflow from St.Jacobs WWTP

Horizon	Population	ADF (m^3/s)	Peak Flow[1] (m^3/s)	Peak Flow (L/s)[1]
2031	2,670	1,330	4,751	55.0
2051	3,080	1,600	5,716	66.2

Note:
1- Peaking factor of 3.6, based on the Historic Flow to the St Jacobs WWTP (2012-2014) presented in 2018 WWTP MP; Peak Flow divided by Average Daily Flow (ADF)

The anticipated peak flow from the St. Jacobs Wastewater Treatment Plant (WWTP) plays a significant role in the Forwell Trunk flows. It is important that this forecast is reassessed as the implementation phase approaches, with a focus on real-time flow data and timing. This reevaluation should be carried out in tandem with the St. Jacobs WWTP Environmental Assessment (EA) to ensure a comprehensive understanding of the system dynamics.

6.5.5.4 Moore Avenue Tributary Area

Through negotiations with the City of Kitchener, additional inflow from the Moore Ave pump station tributary area will be tributary to the Moore Ave sanitary sewer. In the model the inflow was incorporated at the intersection of Moore Ave S and Spur Line Trail (MH L30-23). **Table 6-7** presents the future peak inflow from those SPS, for the 25-year Chicago 3-hour storm event.

Table 6-7: Peak Inflow from Moore Avenue Tributary Area

Model Node	Owner	Horizon	Peak Inflow (L/s)[1]
			25-Year Chicago, 3-Hour Storm
MH 10095703 (L30-23)	City of Kitchener	2031	36.3
		2051	36.6

Note:
1- Peak flow was provided by the City of Kitchener as inflow hydrographs from their Master Plan model (2023)

6.5.5.5 Pumping Stations

For the future scenarios, the two external inflows from Kitchener pumping stations into the Waterloo system need to be reflected for growth. **Table 6-8** presents the future peak inflow from those SPS, for the 25-year Chicago 3-hour storm event. The hydrographs for the different horizon were added in the Waterloo model.

Table 6-8: Peak Inflow from Pump Stations

Pump Station	Model Node	Owner	Horizon	Peak Inflow (L/s)[1]
				25-Year Chicago, 3-Hour Storm
Falconridge	MH 9302 (LX11-1A)	City of Kitchener	2031	31.8
			2051	32.1
Bridgeport	MH 7918 (LEX-14)	Region of Waterloo	2031	135.8
			2051	135.8

Note:
1- Pump station information was provided by the City of Kitchener as inflow hydrographs from their Master Plan model (2023)

6.5.6 Flow Generation

For the future scenarios in 2031 and 2051, the City has provided detailed maps showing where they expect growth. The way they predict population growth and how the expected sanitary loads is determined is explained in detail in **Technical Note #4**. And refer to **Table 4-1** for the existing population (as of 2021), along with projected population for 2031 and 2051.

6.5.7 Horizon 2031 - Sewer System Assessment

Table 6-9 presents the results for the peak inflow at the pumping stations under the 10-year design storm event, for the 2031 projected scenario.

Table 6-9: 2031 Conditions Pumping Stations Results

Pumping Station	10yr Incoming Peak Flow (L/s)	ECA Capacity (L/s)	Firm Capacity (L/s)
Beaver Creek	350.3	370.0	550.0
Colonial[1]	320.4	372.0	540.0*
Frobisher	30.4	35.0	60.0
Malabar	5.2	7.4	6.2
Millenium	52.8	86.0	152.0
Northlands	12.5	57.0	90.0

Notes:
1- Firm capacity at Colonial SPS is estimated based on adding 2 duty pump capacities, i.e., does not consider reduction in capacity associated to two or more simultaneously running pumps

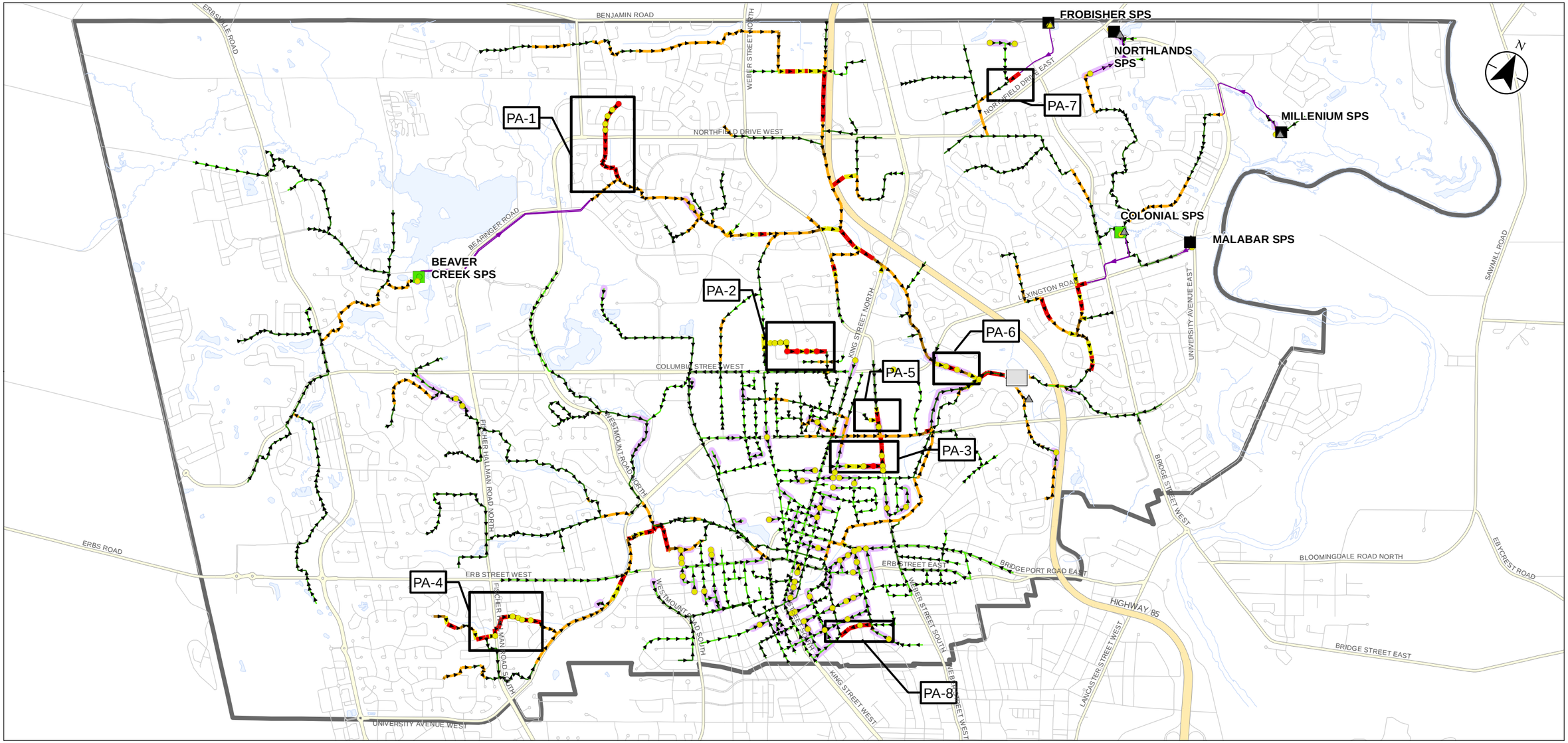
For the 2031 scenario, all pumping stations have a firm capacity that exceeds the incoming peak flow for 10-year design storm event, thus no capacity constraints are observed. Furthermore, in the 25-year scenario for 2031, there are no instances of overflow at the pump stations.

It is also noteworthy that the emergency storage facilities at both Beaver Creek and Colonial pump stations remain unused during the 25-year design storm for the 2051 scenario.

The 2031 scenario modelling results indicate that there are no observed capacity constraints leading to HGL issues under DWF conditions. Under the 25-year design storm event, eight (8) Problem Areas have been identified. Seven of these problem areas are the same as was identified in the existing conditions and one problem area has been introduced. **Table 6-10** lists the current problem areas that still have capacity constraints in the 2031 scenario, along with the additional problem area (PA-8) that is projected to occur in the future scenario. These areas are illustrated in **Figure 6-4**.

Table 6-10: 2031 Scenario Sanitary Sewer Problem Areas

Problem Area ID	Location	Capacity Constraint Description
Existing Problem Area: PA-1 Cedar Highpoint Ave	Highpoint Ave, between Northfield Dr W and Northlake Dr	HGLs within 1.8 m of surface due to undersized pipes. High risk of basement flooding and risk of surface flooding.
Existing Problem Area: PA-2 University Austin Dr	From the intersection of Albert St and Cardill Crescent to the intersection of Austin Dr and Holly St	Risk of basement flooding (HGLs within 1.8 m of surface) and surface flooding due to undersized pipes along Austin Dr.
Existing Problem Area: PA-3 Laurel 2 Lodge St / Weber	From Lodge St to the intersection of Weber St N and University Ave E	Risk of basement and surface flooding due to undersized pipes on Lodge St and Weber St N
Existing Problem Area: PA-4 Maple Hill Maple Hill Creek	From the weir at Thorndale/Westvale to Roosevelt Ave	Risk of basement flooding (HGLs within 1.8 m of surface) due to undersized pipes on private property.
Existing Problem Area: PA-5 Laurel 2 Weber St N	Weber St N, at the intersection of Hickory St E	Surcharging pipes upstream of shallow pipes resulting of an HGL within 1.8 m of surface. Low risk of basement flooding as it is an ICI area.
Existing Problem Area: PA-6 Forwell Trunk Conestoga College	From Lexington Rd to the WWTP	HGLs within 1.8 m of surface due to undersized pipes and shallow pipes. Low risk of basement flooding as no building connection is anticipated along these sewers.
Existing Problem Area: Downstream of Frobisher SPS	Sewers directly downstream of Frobisher forcemain	Capacity constraints in DWF conditions due to undersized pipes, but no risk of basement flooding.
Future Problem Area: PA-8 Laurel 2 Downstream of Moore SPS	Union St E; from Moore St S to Willow St	HGL within 1.8 m of surface (1.75 m) due to undersized pipes on Moore St S, and additional flow from the conveyance of Moore SPS to Waterloo sewer system.



Legend

- WWTP
- Storage
- Storage & Emergency Storage
- Overflow
- Forcemain
- Shallow Sewer

HGL Freeboard

- At or Above Surface
- Within Basement Level (Within 1.8 m of Surface)

Pipe Surcharge State

- Bottleneck Conditions (Undersized Sewer)
- Backwater Conditions

Free-Flowing Conditions

- 0% - 20%
- 20% - 50%
- 50% - 80%
- 80% - 99%

0 500 1,000 metres

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Notes

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Figure No.
6-4

Title
2031 Conditions Sanitary Sewer System
25-Year HGL & Surcharge Results

6.5.8 Horizon 2051 - Sewer System Assessment

Table 6-11 presents the results for the peak inflow at the pumping stations under the 10-year design storm event, for the 2051 projected scenario.

Table 6-11: 2051 Conditions Pumping Stations Results

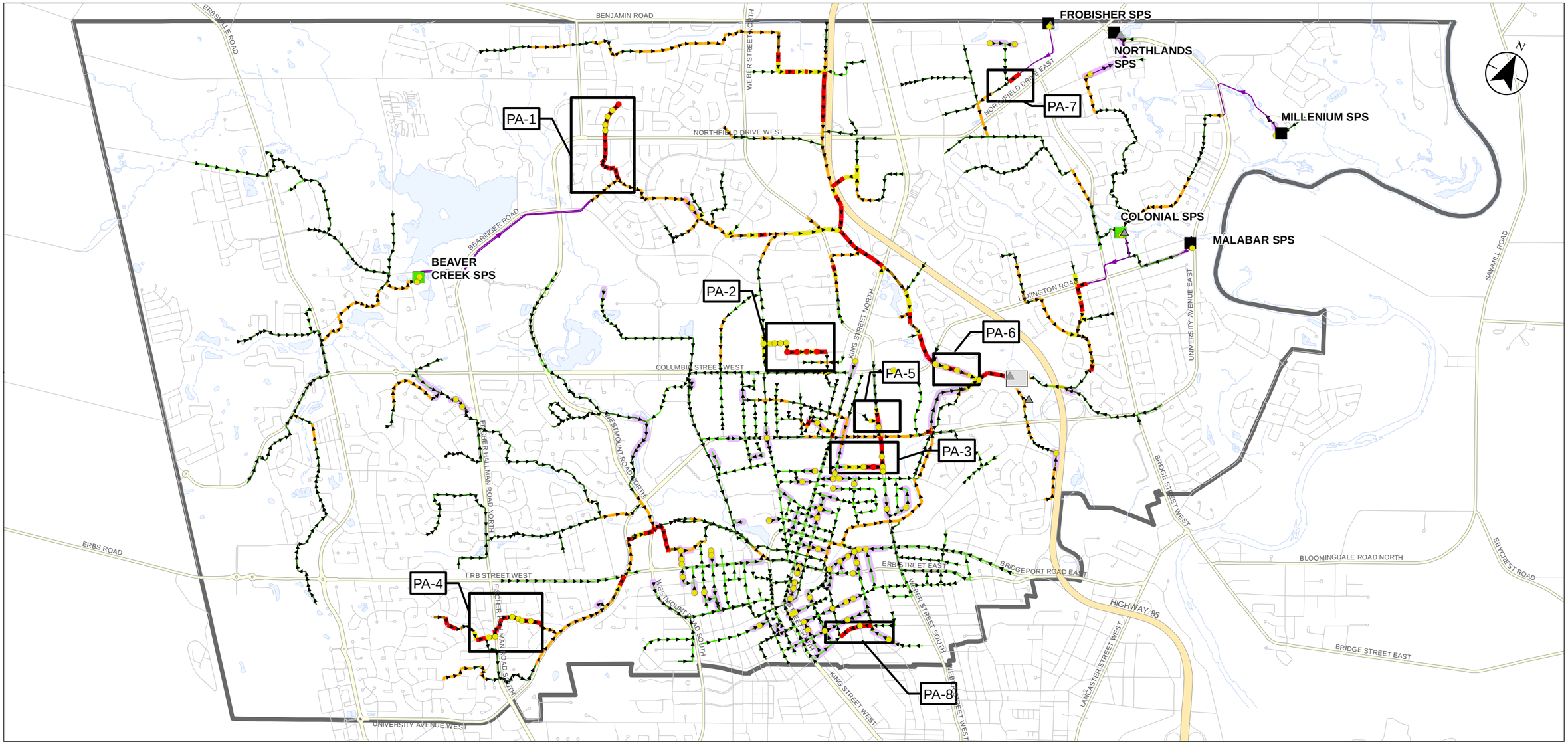
Pumping Station	10yr Incoming Peak Flow (L/s)	ECA Capacity (L/s)	Firm Capacity (L/s)
Beaver Creek	407.4	370.0	550.0
Colonial[1]	353.4	372.0	540.0*
Frobisher	33.9	35.0	60.0
Malabar	6.0	7.4	6.2
Millenium	56.5	86.0	152.0
Northlands	15.3	57.0	90.0

Notes:

1- Firm capacity at Colonial SPS is estimated based on adding 2 duty pump capacities, i.e., does not consider reduction in capacity associated to two or more simultaneously running pumps

The 10-year incoming peak flow is lower than the firm capacity for all pumping stations in the 2051 projection. This indicates that there are no capacity constraints at these stations. However, it's important to note that the flow in the Beaver Creek SPS exceeds the ECA capacity, indicating that an update to the ECA will be necessary. Moreover, the 2051 scenario for a 25-year storm event does not result in any overflow at the pump stations. It's also important to note that the emergency storage at the Beaver Creek and Colonial pump stations remains unutilized during the 25-year design storm in the 2051 projection.

There are no additional problem areas in the sewer system from the 2031 scenario, thus refer to **Table 6-10** for the Sanitary Sewer Problem Areas under the 2051 Scenario. The eight (8) Problem Areas (areas of observed sewer capacity constraints) identified within the 2051 scenario system are shown in the **Figure 6-5**.



Legend

- WTP — WWTP
- Storage
- Storage & Emergency Storage
- Overflow
- Forcemain
- Shallow Sewer

HGL Freeboard

- At or Above Surface
- Within Basement Level (Within 1.8 m of Surface)

Pipe Surcharge State

- Bottleneck Conditions (Undersized Sewer)
- Backwater Conditions

Free-Flowing Conditions

- 0% - 20%
- 20% - 50%
- 50% - 80%
- 80% - 99%

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SANITARY MASTER PLAN

Figure No.
6-5

Title
2051 Conditions Sanitary Sewer System
25-Year HGL & Surcharge Results

6.6 CLIMATE CHANGE

Typically, climate change (CC) predictions result in rainfall increases close to 20% greater than current design storms for the same RG. Therefore, the 25-year Chicago, 3-hour design storm rainfall timeseries was increased by 20% and used as the 25-year including the anticipated effect of climate change event (25-year + CC). The climate change model results are used to test the sensitivity of the sanitary system. Figure 6-6 presents the 25-year + CC conditions.

Under climate change conditions, there is a slight increase in the pipe surcharge, the risk of basement and the surface flooding from the 25-year storm event scenarios. Despite these impacts, the sewer system maintains its resilience with minimal alterations to the level of service. However, in the 2051 scenario under a 25-year + CC event, overflow is observed at Malabar SPS, and additional emergency storage is required at Beaver Creek SPS.

It is noted that the simulations do not directly reflect the potential influences of external water sources such as the storm drainage system and watercourse floodplains, which could have more isolated and concentrated impacts where the collection system infrastructure is submerged due to surface flooding. These potential impacts should be considered as part of infrastructure mitigation planning in high-risk areas.

6.7 PROBLEM AND OPPORTUNITY STATEMENT

A problem and opportunity statement was developed at the onset of the study.

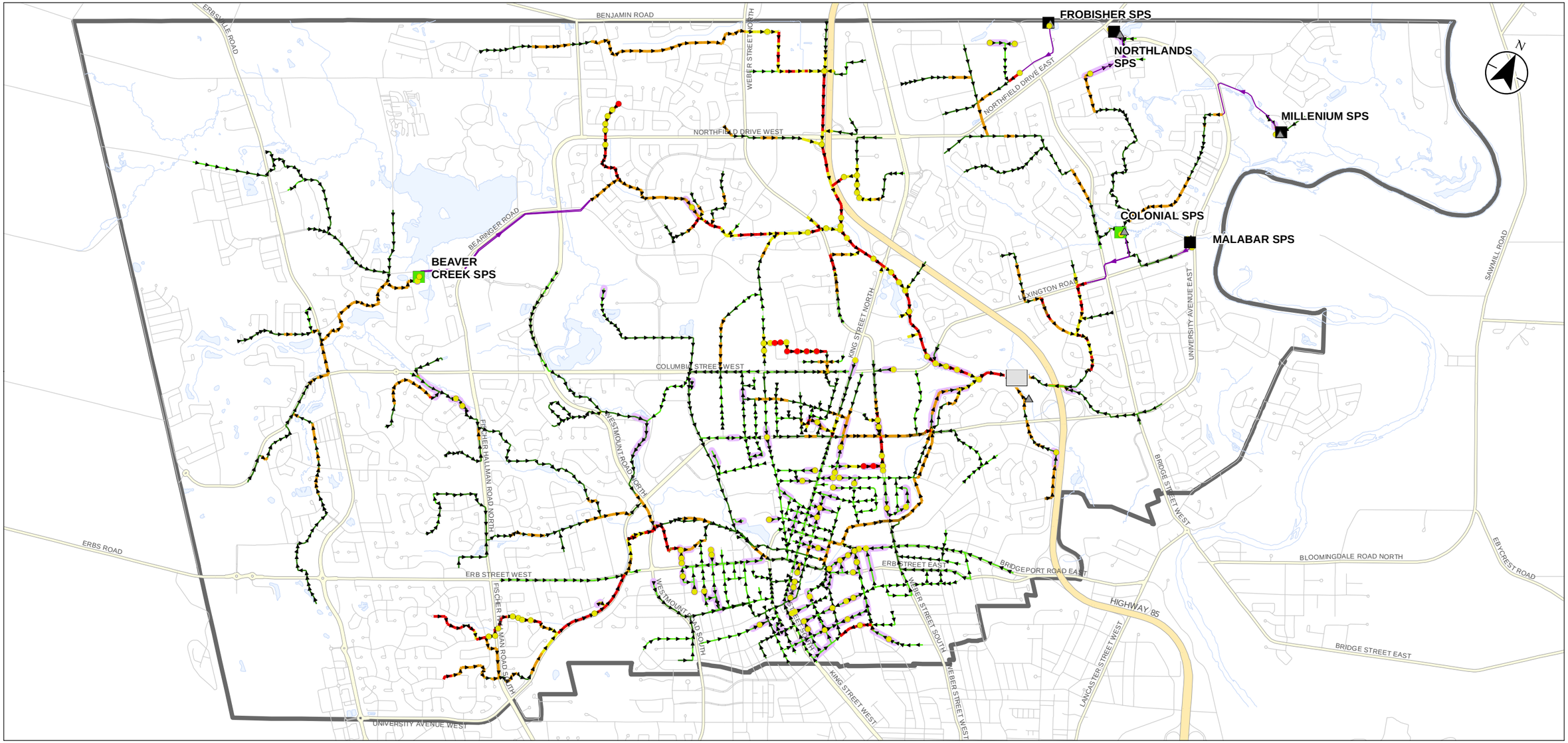
The City of Waterloo has significant sanitary sewer infrastructure which needs to be managed for the community. The existing 2015 Sanitary Master Plan identified growth projections to 2031 and requires updating to reflect the new growth projections to 2051, new planning policies, and the resulting future needs of the community.

The City is undertaking an Update to the 2015 Sanitary Master Plan to examine the City's infrastructure needs. This Update will review improvements to the existing sanitary infrastructure to consider the installation of new sanitary infrastructure and conversion of private services to municipal servicing. The review will consider improvements through to the year 2051.

The City is committed to providing a reliable and sustainable servicing system.

The current sanitary sewer system is subject to surcharge and a potential risk of basement flooding under the conditions of a 25-year design storm event, as detailed in **Sections 6.4.1**, **6.5.7**, and **6.5.8**. This situation poses a risk to residents and the environment, as well as a challenge to accommodate the City's projected growth and development.

The formulation of a comprehensive sanitary sewer Master Plan provides a strategic opportunity to address these capacity issues. An assessment of the existing infrastructure has been conducted, identifying Problem Areas as outlined in **Table 6-10**, both for the existing and future conditions. The sub-sections present the development of alternative solutions to improve the level of service of the sanitary sewer system and support the City's growth.



Legend

- WWTP
- Storage
- Storage & Emergency Storage
- Overflow
- Forcemain
- Shallow Sewer

HGL Freeboard

- At or Above Surface
- Within Basement Level (Within 1.8 m of Surface)

Pipe Surcharge State

- Bottleneck Conditions (Undersized Sewer)
- Backwater Conditions

Free-Flowing Conditions

- 0% - 20%
- 20% - 50%
- 50% - 80%
- 80% - 99%

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Figure No.
6-6

Title
2051 Conditions Sanitary Sewer System
25-Year + Climate Change HGL &
Surcharge Results

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6.8 ALTERNATIVE SOLUTIONS

The proposed infrastructure alternatives are capacity-based upgrades, recommended to mitigate system capacity issues. Subsequent sections will detail the development of these alternatives, addressing the sewer capacity constraints presented in **Table 7-1**. For an in-depth understanding of the proposed solutions, including detailed plan views and profiles, please refer to **Technical Note #4**.

6.8.1 Highpoint Avenue

The area of Highpoint Avenue is at risk of experiencing basement flooding under extreme rainfall events. The existing sewers on Highpoint Avenue require improvements to the sewer capacity.

Three alternatives were evaluated for this area:

- Alternative 1 - Do nothing
- Alternative 2 - Upgrade / Reprofile Sewer (replace the sewer to increase the capacity)
- Alternative 3 - Twin Sewer (add parallel sewer to increase capacity).

Additionally, the Cedar trunk has been identified as observing extraneous flows. Therefore, possible infiltration and inflow (I/I) reduction. Reducing I/I can help manage the amount of water in the system, but it might not be enough to fix all the problems or handle the needs of a growing population. However, it’s still a smart step to take. By reducing I/I, we can improve how the sewer system works and make it more resilient, or capable of adapting to changes, particularly those associated with climate change.

Table 6-12: Evaluation Alternative - Highpoint Avenue

Category	Evaluation Criteria	Do Nothing	Upgrade/Reprofile Sewer	Twin Sewer
Socio-Economic	Potential to impact existing residences, businesses and community features	High potential to impact residents due to risk of basement flooding. Population growth increases basement flooding risk.	Mitigates risk of basement flooding. Temporary construction impacts to the residences on Highpoint Ave. Accommodates population growth.	Mitigates risk of basement flooding. Temporary construction impacts to the residences on Highpoint Ave. Accommodates population growth.
	Potential effect on approved/planned land uses			
	Potential effects on known or potential significant archaeological resources, built heritage resources and cultural landscape features			
	Potential to accommodate planned significant population and job growth in strategic growth areas			
Natural Environment	Potential to impact fish and aquatic habitat	No disturbance to Laurel Creek Conservation Area. No potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk.	Possible impact on Laurel Creek Conservation Area, as the proposed solution crosses Cedar Creek. Potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk due to proximity to the Creek.	Possible impact on Laurel Creek Conservation Area, as the proposed solution crosses Cedar Creek. Potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk due to proximity to the Creek.
	Potential to impact water resources including surface water (i.e. rivers, creeks, etc.), groundwater recharge areas and wellhead protection areas			
	Potential to impact significant natural heritage features (i.e., Laurel Creek Conservation Area)			
	Potential to impact significant wildlife habitat and species at risk			

Category	Evaluation Criteria	Do Nothing	Upgrade/Reprofile Sewer	Twin Sewer
Technical Considerations	Potential land requirements including land purchase and temporary/permanent easements	No improvement to infrastructure or hydraulics of the sewer system. No land acquisition required, and no anticipated impacts on existing utilities.	Upgrades infrastructure and improves hydraulics in the sewer system. No land acquisition required, and no anticipated impacts on existing utilities.	Upgrades infrastructure and improves hydraulics in the sewer system. Requires higher maintenance and operation costs than Alternative 2. No land acquisition required, and no anticipated impacts to existing utilities.
	Constructability			
	Effect on existing utilities and infrastructure			
	Ability to coordinate with existing and planned infrastructure improvements			
	System resiliency and system suitability			
Financial	Lifecycle operations and maintenance costs	No capital cost.	Estimated capital cost and operation & maintenance costs lower than Alternative 3.	Highest estimated capital cost and operation & maintenance costs of all alternatives.
	Estimated capital cost			
Summary Ranking	**Green is the most well aligned with the criterions, Yellow is somewhat aligned with the criterions, and red is the least well aligned with the criterions.**	**Least Preferred**	**Most Preferred**	**Moderately Preferred**

6.8.2 Austin Drive

There are capacity constraints and risk of surface flooding identified on Austin Drive under existing and future model conditions, and as such alternatives have been generated to address these constraints.

Three alternatives were evaluated for this area:

- Alternative 1 - Do nothing
- Alternative 2 - Upgrade / Reprofile Sewer (replace the sewer to increase the capacity)
- Alternative 3 - Twin Sewer (add parallel sewer to increase capacity).

Table 6-13: Evaluation Alternative - Austin Drive

Category	Evaluation Criteria	Do Nothing	Upgrade/Reprofile Sewer	Twin Sewer
Socio-Economic	Potential to impact existing residences, businesses and community features		Mitigates risk of basement flooding, although potential construction impacts to the residences on Austin Dr. Accommodates population growth.	Mitigates risk of basement flooding, although potential construction impacts to the residences on Austin Dr. Accommodates population growth.
	Potential effect on approved/planned land uses			
	Potential effects on known or potential significant archaeological resources, built heritage resources and cultural landscape features			
	Potential to accommodate planned significant population and job growth in strategic growth areas			
Natural Environment	Potential to impact fish and aquatic habitat			
	Potential to impact water resources including surface water (i.e. rivers, creeks, etc.), groundwater recharge areas and wellhead protection areas			
	Potential to impact significant natural heritage features			
	Potential to impact significant wildlife habitat and species at risk			

Category	Evaluation Criteria	Do Nothing	Upgrade/Reprofile Sewer	Twin Sewer
Technical Considerations	Potential land requirements including land purchase and temporary/permanent easements	No improvement to infrastructure or hydraulics of the sewer system. No land acquisition required, and no anticipated impacts on existing utilities.	Upgrades infrastructure and improves hydraulics in the sewer system. No land acquisition required and impacts on existing utilities can be mitigated.	Upgrades infrastructure and improves hydraulics in the sewer system. Requires higher maintenance and operation costs than Alternative 2. No land acquisition required and impacts on existing utilities can be mitigated.
	Constructability			
	Effect on existing utilities and infrastructure			
	Ability to coordinate with existing and planned infrastructure improvements			
	System resiliency and system suitability			
Financial	Lifecycle operations and maintenance costs	No capital cost.	Estimated capital cost and operation & maintenance costs lower than Alternative 3.	Highest estimated capital cost and operation & maintenance costs of all alternatives.
	Estimated capital cost			
Summary Ranking	**Green is the most well aligned with the criterions, Yellow is somewhat aligned with the criterions, and red is the least well aligned with the criterions.**	**Least Preferred**	**Most Preferred**	**Moderately Preferred**

6.8.3 Lodge Street

The area of Lodge Street is at risk of experiencing basement flooding under extreme rainfall events, due to the existing undersized sewer on Lodge Street and Weber Street North. The sewers do not have capacity to convey the flows under these conditions.

Three alternatives were evaluated for this area:

- Alternative 1 - Do nothing
- Alternative 2 - Upgrade / Reprofile Sewer (replace the sewer to increase the capacity)
- Alternative 3 - Twin Sewer (add parallel sewer to increase capacity).

Table 6-14: Evaluation Alternative - Lodge Street

Category	Evaluation Criteria	Do Nothing	Upgrade/Reprofile Sewer	Twin Sewer
Socio-Economic	Potential to impact existing residences, businesses, and community features	High potential to impact residents due to risk of basement flooding. Population growth increases basement flooding risk.	Mitigates risk of basement flooding, although potential construction impacts to the businesses on Lodge St and Weber St N. Accommodates population growth.	Mitigates risk of basement flooding, although potential construction impacts to the businesses on Lodge St and Weber St N. Accommodates population growth.
	Potential effect on approved/planned land uses			
	Potential effects on known or potential significant archaeological resources, built heritage resources and cultural landscape features			
	Potential to accommodate planned significant population and job growth in strategic growth areas			
Natural Environment	Potential to impact fish and aquatic habitat	No disturbance to Laurel Creek. No potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk.	Possible impact on Laurel Creek, as the proposed solution is located within the Laurel Creek floodplain. Low potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk.	Possible impact on Laurel Creek, as the proposed solution is located within the Laurel Creek floodplain. Low potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk.
	Potential to impact water resources including surface water (i.e. rivers, creeks, etc.), groundwater recharge areas and wellhead protection areas			
	Potential to impact significant natural heritage features (i.e., Laurel Creek)			
	Potential to impact significant wildlife habitat and species at risk			

Category	Evaluation Criteria	Do Nothing	Upgrade/Reprofile Sewer	Twin Sewer
Technical Considerations	Potential land requirements including land purchase and temporary/permanent easements	No improvement to infrastructure or hydraulics of the sewer system. No land acquisition required, and no anticipated impacts on existing utilities.	Upgrades infrastructure and improves hydraulics in the sewer system. No land acquisition required and impacts on existing utilities can be mitigated.	Upgrades infrastructure and improves hydraulics in the sewer system. Requires higher maintenance and operation costs than Alternative 2. No land acquisition required and impacts on existing utilities can be mitigated.
	Constructability			
	Effect on existing utilities and infrastructure			
	Ability to coordinate with existing and planned infrastructure improvements			
	System resiliency and system suitability			
Financial	Lifecycle operations and maintenance costs	No capital cost.	Estimated capital cost and operation & maintenance costs lower than Alternative 3.	Highest estimated capital cost and operation & maintenance costs of all alternatives.
	Estimated capital cost			
Summary Ranking	**Green is the most well aligned with the criterions, Yellow is somewhat aligned with the criterions, and red is the least well aligned with the criterions.**	**Least Preferred**	**Most Preferred**	**Moderately Preferred**

6.8.4 Thorndale Drive & Westvale Drive

The sanitary sewers on Maple Hill Creek do not have capacity for the flows under extreme rainfall event conditions. The location of the capacity constraint along the Maple Hill Trunk is in an existing easement. There is a weir in a MH at the intersection of Thorndale Drive & Westvale Drive currently directing the flow primarily to Thorndale Drive sewer, upstream of the location of the capacity constraint.

Four alternatives were evaluated for this area to address the capacity constraint:

- Alternative 1 - Do nothing
- Alternative 2 - Upgrade / Reprofile Sewer (replace the sewer to increase the capacity)
- Alternative 3 - Twin Sewer (add parallel sewer to increase capacity)
- Alternative 4 – Weir Adjustment (overflow structure) to divert flows along an alternate route and potentially utilize available capacity in a separate sewer system.

Table 6-15: Evaluation Alternative - Thorndale Drive & Westvale Drive

Category	Evaluation Criteria	Do Nothing	Upgrade/Reprofile Sewer	Twin Sewer	Weir Adjustment
Socio-Economic	Potential to impact existing residences, businesses and community features	High potential to impact residents due to risk of basement flooding. Population growth increases basement flooding risk.	Mitigates risk of basement flooding. Construction impacts to the residences, as the proposed upgrade sewers are located on private properties. Accommodates population growth.	Mitigates risk of basement flooding. Construction impacts to the residences, as the proposed upgrade sewers are located on private properties. Accommodates population growth.	Mitigates risk of basement flooding, and minimal impact to residences. Accommodates population growth.
	Potential effect on approved/planned land uses				
	Potential effects on known or potential significant archaeological resources, built heritage resources and cultural landscape features				
	Potential to accommodate planned significant population and job growth in strategic growth areas				
Natural Environment	Potential to impact fish and aquatic habitat	No disturbance to Maple Hill Creek. No potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk.	Possible impact on Maple Hill Creek, as the proposed solution is located near the Creek. Potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk due to proximity to the Creek.	Possible impact on Maple Hill Creek, as the proposed solution is located near the Creek. Potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk due to proximity to the Creek.	No disturbance to Maple Hill Creek as project is distant from the Creek. No potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk.
	Potential to impact water resources including surface water (i.e. rivers, creeks, etc.), groundwater recharge areas and wellhead protection areas				
	Potential to impact significant natural heritage features (i.e., Maple Hill Creek)				
	Potential to impact significant wildlife habitat and species at risk				

Category	Evaluation Criteria	Do Nothing	Upgrade/Reprofile Sewer	Twin Sewer	Weir Adjustment
Technical Considerations	Potential land requirements including land purchase and temporary/permanent easements	No improvement to infrastructure or hydraulics of the sewer system. No land acquisition required, and no anticipated impacts on existing utilities.	Improves infrastructure and hydraulics but requires construction through easement. Impacts on existing utilities can be mitigated.	Improves infrastructure and hydraulics but requires construction through easement. Requires higher maintenance and operation than Alternative 2. Impacts on existing utilities can be mitigated.	Well Aligned with Criteria; improves hydraulics in sewer system and ease of access for maintenance and operation. No land acquisition required, and no anticipated impacts on existing utilities. Well aligned, ease of access for maintenance and operation.
	Constructability				
	Effect on existing utilities and infrastructure				
	Ability to coordinate with existing and planned infrastructure improvements				
	System resiliency and system suitability				
Financial	Lifecycle operations and maintenance costs	No capital cost.	Estimated capital cost and operation & maintenance costs lower than Alternative 3, but higher than Alternative 4	Highest estimated capital cost and operation & maintenance costs of all alternatives.	Estimated capital cost and operation & maintenance costs lower than Alternative 2 and 3.
	Estimated capital cost				
Summary Ranking	**Green is the most well aligned with the criterions, Yellow is somewhat aligned with the criterions, and red is the least well aligned with the criterions.**	**Least Preferred**	**Moderately Preferred**	**Least Preferred**	**Most Preferred**

6.8.5 Weber Street North

The sewers on Weber Street North have capacity constraints, but the HGL issue is mainly due to shallow sewer.

Three alternatives were evaluated for this area:

- Alternative 1 - Do nothing
- Alternative 2 - Upgrade / Reprofile Sewer (replace the sewer to increase the capacity)
- Alternative 3 - Twin Sewer (add parallel sewer to increase capacity)

Table 6-16: Evaluation Alternative - Weber Street North

Category	Evaluation Criteria	Do Nothing	Upgrade/Reprofile Sewer	Twin Sewer
Socio-Economic	Potential to impact existing residences, businesses and community features	Sewer operates under surcharge condition; however, the commercial area would not have basement connections to this section, thus low risk of basement flooding. Growth increases surcharge but can be accommodated.	Mitigates risk of basement flooding, although potential construction impacts to the businesses on Weber St N. Accommodates population growth.	Mitigates risk of basement flooding, although potential construction impacts to the businesses on Weber St N. Accommodates population growth.
	Potential effect on approved/planned land uses			
	Potential effects on known or potential significant archaeological resources, built heritage resources and cultural landscape features			
	Potential to accommodate planned significant population and job growth in strategic growth areas			
Natural Environment	Potential to impact fish and aquatic habitat	No disturbance; no natural environment near the area. No potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk.	Possible impact on Laurel Creek, as the proposed solution is located within the Laurel Creek floodplain. Low potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk.	Possible impact on Laurel Creek, as the proposed solution is located within the Laurel Creek floodplain. Low potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk.
	Potential to impact water resources including surface water (i.e., rivers, creeks, etc.), groundwater recharge areas and wellhead protection areas			
	Potential to impact significant natural heritage features			
	Potential to impact significant wildlife habitat and species at risk			

Category	Evaluation Criteria	Do Nothing	Upgrade/Reprofile Sewer	Twin Sewer
Technical Considerations	Potential land requirements including land purchase and temporary/permanent easements	No land acquisition required, and no anticipated impacts on existing utilities.	Improves infrastructure and hydraulics. No land acquisition required and impacts on existing utilities can be mitigated.	Improves infrastructure and hydraulics. Requires higher maintenance and operation costs than Alternative 2. No land acquisition required and impacts on existing utilities can be mitigated.
	Constructability			
	Effect on existing utilities and infrastructure			
	Ability to coordinate with existing and planned infrastructure improvements			
	System resiliency and system suitability			
Financial	Lifecycle operations and maintenance costs	No capital cost.	Estimated capital cost and operation & maintenance costs lower than Alternative 3.	Highest estimated capital cost and operation & maintenance costs of all alternatives.
	Estimated capital cost			
Summary Ranking	**Green is the most well aligned with the criterions, Yellow is somewhat aligned with the criterions, and red is the least well aligned with the criterions.**	**Most Preferred**	**Moderately Preferred**	**Least Preferred**

6.8.6 Forwell Trail

In the area of Forwell Trail, the sanitary sewer experiences high water levels during extreme rainfall events. The pipes in this area are undersized and shallow, which typically would be a cause for concern. However, in this specific case, there is a low risk of basement flooding because there are no building connections present along these sewers. This means that even if the water levels rise in the sewer during heavy rainfall, it will not affect any buildings because they are not directly connected to these particular sewers.

Three alternatives were evaluated for this area:

- Alternative 1 - Do nothing
- Alternative 2 - Upgrade / Reprofile Sewer (replace the sewer to increase the capacity)
- Alternative 3 - Twin Sewer (add parallel sewer to increase capacity)

Therefore, despite the high-water levels and undersized pipes, the ‘do nothing’ alternative is recommended for Forwell Trail as the risk of impact is minimal. Additionally, considering the potential environmental impact on Hillside Park Reserve due to the location of the problem area within the park, the ‘do nothing’ alternative becomes more favorable.

However, the Forwell trunk is currently subject to surcharge issues under both existing and future conditions. As such, it is important to closely review the assumptions regarding growth, external contribution flows, and their timing to ensure alignment with the actual conditions.

The primary goal of this detailed evaluation is to mitigate any potential intensification of the surcharge conditions in the Forwell system. If the actual flows surpass the initial assumptions, it could exacerbate the surcharge issues, thereby increasing the risk of basement flooding. Consequently, it is recommended to maintain ongoing monitoring and make necessary adjustments to the growth assumptions and external contribution flows.

Table 6-17: Evaluation Alternative - Forwell Trail

Category	Evaluation Criteria	Do Nothing	Upgrade/Reprofile Sewer	Twin Sewer
Socio-Economic	Potential to impact existing residences, businesses and community features	Sewer operates in a surcharge condition, however, there are no basement connections to this section so low risk of basement flooding. Growth increases surcharge but can be accommodated.	Mitigates high water levels in the sanitary sewer, although potential construction impacts. Accommodates population growth.	Mitigates high water levels in the sanitary sewer, although potential construction impacts. Accommodates population growth.
	Potential effect on approved/planned land uses			
	Potential effects on known or potential significant archaeological resources, built heritage resources and cultural landscape features			
	Potential to accommodate planned significant population and job growth in strategic growth areas			
Natural Environment	Potential to impact fish and aquatic habitat	No disturbance to Hillside Park Reserve. No potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk.	Potential impact on Hillside Park Reserve, as the solution is located in the Park. Potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk due to proximity to the Creek.	Potential impact on Hillside Park Reserve, as the solution is located in the Park. Potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk due to proximity to the Creek.
	Potential to impact water resources including surface water (i.e. rivers, creeks, etc.), groundwater recharge areas and wellhead protection areas			
	Potential to impact significant natural heritage features (i.e., Hillside Park Reserve)			
	Potential to impact significant wildlife habitat and species at risk			

Category	Evaluation Criteria	Do Nothing	Upgrade/Reprofile Sewer	Twin Sewer
Technical Considerations	Potential land requirements including land purchase and temporary/permanent easements	Shallow pipes and no residential basement connections. No land acquisition required, and no anticipated impacts on existing utilities.	Improves infrastructure and hydraulics. No land acquisition required, and no anticipated impacts on existing utilities.	Improves infrastructure and hydraulics. Requires higher maintenance and operation costs than Alternative 2. No land acquisition required, and no anticipated impacts on existing utilities.
	Constructability			
	Effect on existing utilities and infrastructure			
	Ability to coordinate with existing and planned infrastructure improvements			
	System resiliency and system suitability			
Financial	Lifecycle operations and maintenance costs	No capital cost.	Estimated capital cost and operation & maintenance costs lower than Alternative 3.	Highest estimated capital cost and operation & maintenance costs of all alternatives.
	Estimated capital cost			
Summary Ranking	**Green is the most well aligned with the criterions, Yellow is somewhat aligned with the criterions, and red is the least well aligned with the criterions.**	**Most Preferred**	**Moderately Preferred**	**Least Preferred**

6.8.7 Frobisher Drive

Capacity constraints have been identified on Frobisher Drive under dry weather flow. There is no HGL issue under extreme events, however as presented in TM4, capacity constraints were identified under DWF conditions and thus this sewer was identified as a problem area.

Three alternatives were evaluated for this area:

- Alternative 1 - Do nothing
- Alternative 2 - Upgrade / Reprofile Sewer (replace the sewer to increase the capacity)
- Alternative 3 - Twin Sewer (add parallel sewer to increase capacity)

Table 6-18: Evaluation Alternative - Frobisher Drive

Category	Evaluation Criteria	Do Nothing	Upgrade/Reprofile Sewer	Twin Sewer
Socio-Economic	Potential to impact existing residences, businesses and community features	Potential to impact residents due to sewer capacity constraints under DWF. Population growth increases capacity constraints.	Mitigates capacity constraints, although potential construction impacts to the businesses on Frobisher Dr. Accommodates population growth.	Mitigates capacity constraints, although potential construction impacts to the businesses on Frobisher Dr. Accommodates population growth.
	Potential effect on approved/planned land uses			
	Potential effects on known or potential significant archaeological resources, built heritage resources and cultural landscape features			
	Potential to accommodate planned significant population and job growth in strategic growth areas			
Natural Environment	Potential to impact fish and aquatic habitat	No disturbance; no natural environment near the area. No potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk.	No natural environment near the area, as the proposed solution is located on Frobisher Dr. No potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk.	No natural environment near the area, as the proposed solution is located on Frobisher Dr. No potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk.
	Potential to impact water resources including surface water (i.e. rivers, creeks, etc.), groundwater recharge areas and wellhead protection areas			
	Potential to impact significant natural heritage features			
	Potential to impact significant wildlife habitat and species at risk			

Category	Evaluation Criteria	Do Nothing	Upgrade/Reprofile Sewer	Twin Sewer
Technical Considerations	Potential land requirements including land purchase and temporary/permanent easements	No improvement to infrastructure or hydraulics of the sewer system. No land acquisition required, and no impacts on existing utilities.	Upgrades infrastructure and improves hydraulics in the sewer system. No land acquisition required and impacts on existing utilities can be mitigated.	Upgrades infrastructure and improves hydraulics in the sewer system. Requires higher maintenance and operation than the sewer upgrade alternative. No land acquisition required and impacts on existing utilities can be mitigated.
	Constructability			
	Effect on existing utilities and infrastructure			
	Ability to coordinate with existing and planned infrastructure improvements			
	System resiliency and system suitability			
Financial	Lifecycle operations and maintenance costs	No capital cost.	Estimated capital cost and operation & maintenance costs lower than Alternative 3.	Highest estimated capital cost and operation & maintenance costs of all alternatives.
	Estimated capital cost			
Summary Ranking	**Green is the most well aligned with the criterions, Yellow is somewhat aligned with the criterions, and red is the least well aligned with the criterions.**	**Least Preferred**	**Most Preferred**	**Moderately Preferred**

6.8.8 Union Street East

Additional inflow from the Moore Ave pump station tributary area in Kitchener will be tributary to the Moore Ave sanitary sewer in Waterloo. In the model the inflow was incorporated at the intersection of Moore Ave S and Spur Line Trail (MH L30-23). In the future conditions, the area of Union Street East is at risk of basement flooding under extreme rainfall events.

Three alternatives were evaluated for this area:

- Alternative 1 - Do nothing
- Alternative 2 - Upgrade / Reprofile Sewer (replace the sewer to increase the capacity)
- Alternative 3 - Twin Sewer (add parallel sewer to increase capacity)

Table 6-19: Evaluation Alternative - Union Street East

Category	Evaluation Criteria	Do Nothing	Upgrade/Reprofile Sewer	Twin Sewer
Socio-Economic	Potential to impact existing residences, businesses and community features	Potential to impact residents due to risk of basement flooding. Population growth increases basement flooding risk.	Mitigates risk of basement flooding and align with the City's planned infrastructure upgrade on Union St E. Accommodates population growth.	Mitigates risk of basement flooding and align with the City's planned infrastructure upgrade on Union St E. Accommodates population growth.
	Potential effect on approved/planned land uses			
	Potential effects on known or potential significant archaeological resources, built heritage resources and cultural landscape features			
	Potential to accommodate planned significant population and job growth in strategic growth areas			
Natural Environment	Potential to impact fish and aquatic habitat	No disturbance; no natural environment near the area. No potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk.	No natural environment near the area, as the proposed solution is located on Union St E. No potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk.	No natural environment near the area, as the proposed solution is located on Union St E. No potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk.
	Potential to impact water resources including surface water (i.e. rivers, creeks, etc.), groundwater recharge areas and wellhead protection areas			
	Potential to impact significant natural heritage features			
	Potential to impact significant wildlife habitat and species at risk			

Category	Evaluation Criteria	Do Nothing	Upgrade/Reprofile Sewer	Twin Sewer
Technical Considerations	Potential land requirements including land purchase and temporary/permanent easements	No improvement to infrastructure or hydraulics of the sewer system. No land acquisition required, and no impacts on existing utilities.	Upgrades infrastructure and improves hydraulics in the sewer system. No land acquisition required and impacts on existing utilities can be mitigated.	Upgrades infrastructure and improves hydraulics in the sewer system. Requires higher maintenance and operation than the sewer upgrade alternative. No land acquisition required and impacts on existing utilities can be mitigated.
	Constructability			
	Effect on existing utilities and infrastructure			
	Ability to coordinate with existing and planned infrastructure improvements			
	System resiliency and system suitability			
Financial	Lifecycle operations and maintenance costs	No capital cost.	Estimated capital cost and operation & maintenance costs lower than Alternative 3.	Highest estimated capital cost and operation & maintenance costs of all alternatives.
	Estimated capital cost			
Summary Ranking	**Green is the most well aligned with the criterions, Yellow is somewhat aligned with the criterions, and red is the least well aligned with the criterions.**	**Least Preferred**	**Most Preferred**	**Moderately Preferred**

6.9 EVALUATION OF ALTERNATIVE SOLUTIONS

The selection of the evaluation criteria was informed by the 2014 Master Plan and the EA guidance document. **Table 6-20** outlines the criteria used for the evaluation of the recommended servicing alternatives. Depending on comments received from agencies, Indigenous communities, stakeholders and members of the public, criteria may be added or refined.

Table 6-20: Evaluation Criteria

Category	Description
Socio-Economic Environment	• Potential to impact existing residences, businesses and community features • Potential effect on approved/planned land uses • Potential effects on known or potential significant archaeological resources, built heritage resources and cultural landscape features • Potential to accommodate planned significant population and job growth in strategic growth areas
Natural Environment	• Potential to impact fish and aquatic habitat • Potential to impact water resources including surface water (i.e. rivers, creeks, etc.), groundwater recharge areas and wellhead protection areas • Potential to impact significant natural heritage features (i.e., woodlands, parks, etc.) • Potential to impact significant wildlife habitat and species at risk
Technical Considerations	• Potential land requirements including land purchase and temporary/permanent easements • Constructability • Effect on existing utilities and infrastructure • Ability to coordinate with existing and planned infrastructure improvements • System resiliency and system suitability
Financial	• Lifecycle operations and maintenance costs • Estimated capital cost

A review was conducted at the location of each constraint to allow utility conflicts to be avoided during the development of servicing alternatives. Procedure F-6-1 published by the MECP requires watermain to be aligned with a minimum horizontal separation from sanitary sewers of 2.5 m. Alternative solutions for addressing the identified capacity constraints are presented in the following sections.

6.10 INFLOW AND INFILTRATION REDUCTION & MITIGATION PROGRAMS

The infiltration and inflow (I/I) can cause problems like basement flooding, and overflows. It can also lead to high costs for treating the extra water and reduce the system's ability to handle future growth. Old infrastructure, improper connections, and changing weather patterns can all increase I/I.

In the hydraulic model of the sewer system, I/I is represented as groundwater infiltration (GWI rate) and wet weather inflows using the RTK method (Total R). **Figure 6-7** shows the areas where the potential to reduce I/I, based on the calibrated GWI rates and Total R per sewershed.

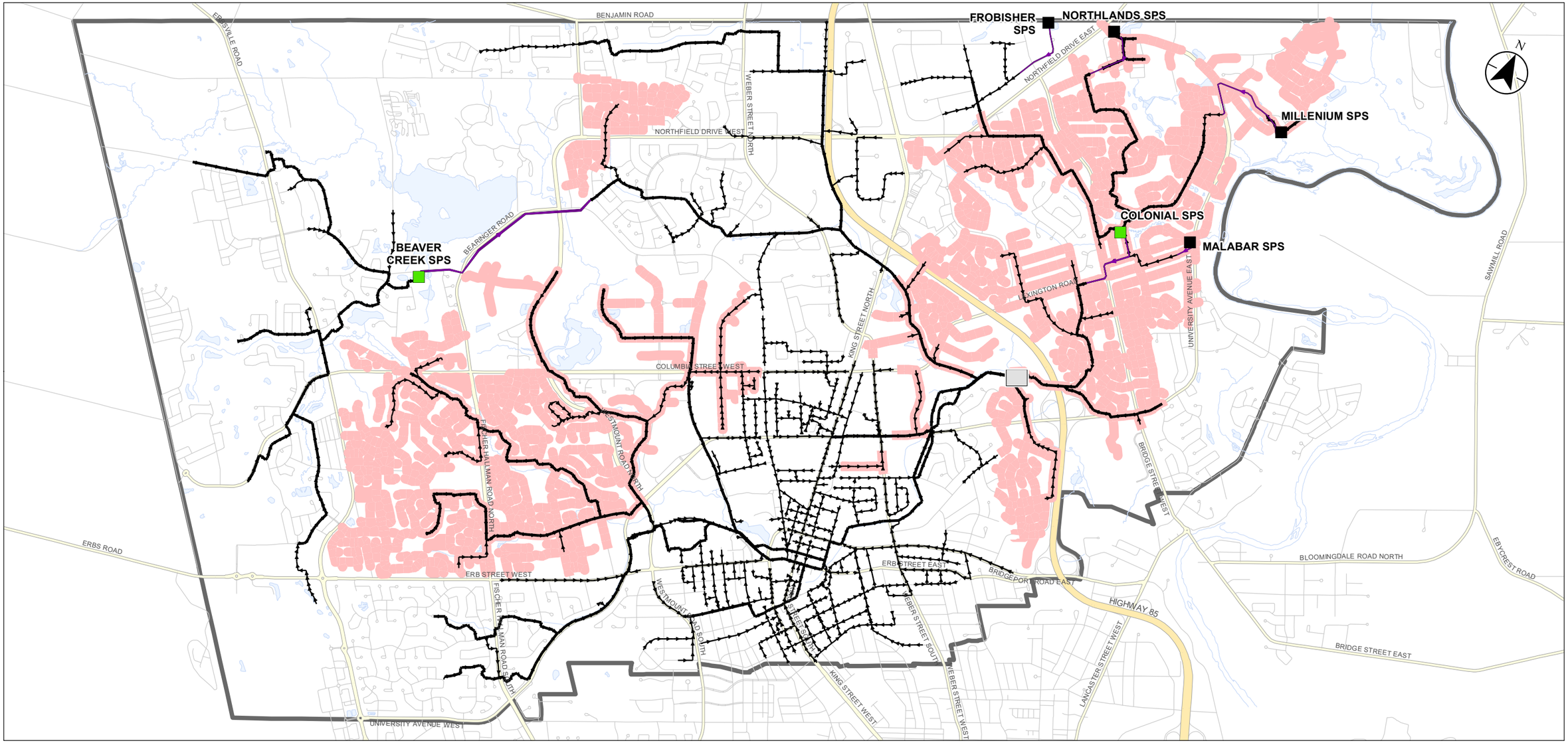
A comprehensive I/I Program is tied to other infrastructure programs like asset renewal, capital works planning, operational improvements, and growth management/capacity assurance programs. A successful strategy ensures long-term capacity while maintaining the condition of the assets. Key components of a successful I/I Program include ongoing data collection, performance monitoring, enforcing design and construction standards, assessing sewer integrity/condition, hydraulic performance assessments, and overall data management and analytics. For more details on the I/I mitigation program, refer to **Technical Note #5-6**.

6.11 RAINFALL AND FLOW MONITORING

As a best management practices, it is recommended to establish a Rainfall and Flow Monitoring Program. This program would look after all the equipment and contracts related to monitoring rainfall and flow. It would also strategically plan and manage the collection of data. This data helps support various factors that affect the existing and future collection system. These factors include maintaining the hydraulic model, reducing unnecessary water flow into the system, managing operations and maintenance, responding to emergencies, planning and designing capital projects, managing assets, and planning for growth.

6.12 SANITARY HYDRAULIC MODEL UPDATES & MAINTENANCE

Leading utilities use hydraulic modelling for capital planning and operations. This model, updated with limited project data, is a functional tool for master planning. As best practices, it should be continually refined based on areas lacking monitoring coverage. Maintenance activities include physical network improvements, validation or recalibration from Rainfall and Flow Monitoring Program data, and annual updates for changes due to construction, operation, or population growth. **Figure 6-7** presents the I/I reduction target areas based on the calibrated GWI rates and Total R per sewershed.



Legend

- WWTP
- Storage
- Storage & Emergency Storage
- Forcemain

Modelled Sanitary Sewers

- Local Main
- Trunk Main

I/I Reduction Target Area

GWI Rates Greater or Equal to 0.05 L/s/ha and/or Total R Value Greater or Equal to 3%

0 500 1,000 metres

1:37,560 (At original document size of 11x17)

Stantec

Project Location
City of Waterloo

165640363 REVA
Prepared by HB on 2023-10-20

Client/Project
CITY OF WATERLOO
SANITARY MASTER PLAN

Figure No.
6-7

Title
I/I Reduction Target Areas

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
2. Contains information provided by the City of Waterloo under licence.

7.0 RECOMMENDATIONS AND STAGING SERVICING STRATEGIES

7.1 PREFERRED ALTERNATIVE SOLUTION

The preferred proposed solutions are presented in **Table 7-1**, along with the estimated Opinion of Probable Cost (OPC) per solution. Solutions are listed by their Project ID (PA-#, where PA refers to Problem Area solutions).

The solutions are ordered based on a high-level assessment of priority, which predominately focuses on prioritizing solutions that are required in the near-term to resolve issues experienced in existing conditions and in the medium-term to resolve issues that are triggered under 2031 conditions. Within each horizon however, the prioritization is assumed equal.

The OPCs are considered Class D estimates (+/- 25-30%) and are provided based on 2023 dollars. These costs have been rounded to the nearest thousand for the recommended budgetary estimate. These OPCs can be used to help inform the City's budgeting process for the three-year capital budget cycles. Thus, all near-term projects should be included within the next budgeting process (2027-2030 budget), while the medium-term solution should be accounted for in future budgets.

In most cases, the required solutions are simple in nature, in that only a few pipe segment upgrades within City-owned Right-of-Way (ROW) are required to reduce HGLs below 1.8 m from surface.

The following **Figure 7-1** illustrates the locations of the proposed solution. Refer to **Technical Note #4** for further solution details, including close-up plan views and profiles of each of the proposed solutions.

Table 7-1: Existing and Future Conditions Capacity-Based Sewer Solutions

Problem Area ID	Scenario Triggered	Preferred Alternative	Solution Description	Estimated Opinion of Probable Cost	Contingency Allowance (30%)	Engineering Allowance (20%)	Recommended Budgetary Estimate
PA-1: Highpoint Avenue	Existing (Near-Term Priority)	Alt 2	Replacement of 10 lengths of sewer - upsize 2 lengths of sewer from 300 mm diameter to 375 mm diameter sewer, and 8 lengths of sewer from 375 mm diameter to 450 mm diameter sewer	$1,925,190	$577,557	$500,549	$3,004,000
PA-2: Austin Drive	Existing (Near-Term Priority)	Alt 2	Replacement of 4 lengths of sewer - upsize 3 lengths of sewer from 200 mm diameter to 300 mm diameter sewer, and 1 length of sewer from 200 mm diameter to 375 mm diameter sewer	$759,290	$227,787	$197,415	$1,185,000
PA-3: Lodge Street	Existing (Near-Term Priority)	Alt 2	Replacement of 5 lengths of sewer - upsize 1 length of sewer from 200 mm diameter to 250 mm diameter sewer, 2 lengths of sewer from 200 mm diameter to 300 mm diameter sewer, and 2 lengths of sewer from 250 mm diameter to 375 mm diameter sewer	$1,321,000	$396,300	$343,460	$2,061,000
PA-4: Thorndale Drive & Westvale Drive	Existing (Near-Term Priority)	Alt 4	Option A - In-place reconfiguration of the concrete weir (MH MPL-65)	$67,000	$20,100	$17,420	$105,000
			Option B - Full removal and replacement of the concrete weir (MH MPL-65)	$382,923	$114,877	$99,560	$598,000

Problem Area ID	Scenario Triggered	Preferred Alternative	Solution Description	Estimated Opinion of Probable Cost	Contingency Allowance (30%)	Engineering Allowance (20%)	Recommended Budgetary Estimate
PA-5: Weber Street North	Existing (Near-Term Priority)	Alt 1	Do nothing	$-	$-	$-	$-
PA-6: Forwell Trail	Existing (Near-Term Priority)	Alt 1	Do nothing	$-	$-	$-	$-
PA-7: Frobisher Drive	Existing (Near-Term Priority)	Alt 2	Replacement of 2 lengths of sewer downstream of the forcemain - upsizing from 200 mm diameter to 250 mm diameter sewer	$442,025	$132,608	$114,927	$690,000
PA-8: Union Street East	2031 (Medium-Term Priority)	Alt 2	Replacement of 1 length of sewer downstream of the inflow from Kitchener (decommission of Moore PS) - upsizing from 225 mm diameter to 250 mm diameter sewer	$392,074	$117,622	$101,939	$612,000

7.1.1 Alternatives Review

As presented in **Table 7-1**, there are two options for the Thorndale Drive & Westvale Drive Avenue. The comparison and the preferred option are presented in **Table 7-2**.

Table 7-2: Alternatives Evaluation

Evaluation Element	Option A	Option B
Project ID	**CB-4**	
Location	**Thorndale Drive & Westvale Drive**	
Description	In-place reconfiguration of the concrete weir (MH MPL-65)	Full removal and replacement of the concrete weir (MH MPL-65)
Opinion of Probable Cost	$105,000	$598,000
Pros	Avoids easement/private property upgrades resulting in fewer permitting requirements Reduces HGL concerns in Maple Hill Area Lower immediate cost	Avoids easement/private property upgrades resulting in fewer permitting requirements Reduces HGL concerns in Maple Hill Area Higher life cycle
Recommendation	**Option A** – Due to the minimization of the cost	

As is indicated, Option A is recommended for the Thorndale Drive & Westvale Drive problem area. The total recommended budgetary estimate for all proposed solutions, including only the recommended alternatives for CB-4, is **$7,657,000**.

PA-1
Alternative 2

PA-2
Alternative 2

PA-3
Alternative 2

PA-4
Alternative 4 - Option A

PA-5
Alternative 1

PA-6
Alternative 1

PA-7
Alternative 2

PA-8
Alternative 2

FROBISHER SPS

NORTHLANDS SPS

MILLENIUM SPS

COLONIAL SPS

MALABAR SPS

BEAVER CREEK SPS

BENJAMIN ROAD
ERBSVILLE ROAD
WEBER STREET NORTH
NORTHFIELD DRIVE WEST
NORTHFIELD DRIVE EAST
BEARINGER ROAD
LEXINGTON ROAD
UNIVERSITY AVENUE EAST
SAWMILL ROAD
COLUMBIA STREET WEST
KING STREET NORTH
FISHER HALLMAN ROAD NORTH
WESTMOUNT ROAD NORTH
BRIDGE STREET WEST
ERBS ROAD
ERB STREET WEST
FISHER HALLMAN ROAD SOUTH
WESTMOUNT ROAD SOUTH
KING STREET EAST
ERB STREET EAST
BRIDGEPORT ROAD EAST
WEBER STREET SOUTH
KING STREET WEST
LANCASTER STREET WEST
HIGHWAY 85
BLOOMINGDALE ROAD NORTH
EBYCREST ROAD
BRIDGE STREET EAST
UNIVERSITY AVENUE WEST

N

Legend

- WWTP
- Storage
- Storage & Emergency Storage
- Overflow
- Forcemain

Modelled Sanitary Sewers

- Local Main
- Trunk Main
- Upgraded/Reprofiled Sewer

0 500 1,000 metres

1:37,500 (At original document size of 11x17)

Stantec

Project Location
City of Waterloo

165640363 REVA
Prepared by HB on 2023-10-20

Client/Project
CITY OF WATERLOO
SANITARY MASTER PLAN

Figure No.
7-1

Title
Proposed Capabity-Based Solutions

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Contains information provided by the City of Waterloo under licence.

7.1.2 Forwell Trunk Condition and Recommendations

The recommendations provided in prior sections primarily address the capacity of the system, including the Forwell Trunk, without considering the condition of the system. The Forwell Trunk was constructed in phases, with some downstream segments being more than 60 years old. Segments of the Forwell Trunk have been assessed through CCTV scoring, which indicates the presence of structural defects.

Although the Forwell Trunk was not recommended for an upgrade when assessed on the basis of capacity constraints, as discussed in **Section 6.8.6**, some sewer segments experience surcharging, and sections of the trunk sewer are undersized and shallow. Given the significance of the Forwell Trunk, the City will be conducting further investigations into the condition of the system.

As part of the Master Plan, a contingency allowance will be established to address potential replacement needs for portions of the Forwell Trunk. The criteria for selecting the segments of the Forwell Trunk to be included in the cost estimates for the contingency allowance are based on:

1. High and Medium Critical CCTV Scoring: Segments along Forwell Trunk with high and medium critical CCTV scores.

2. Low-Risk Critical Scoring within Floodplain: Segments within the floodplain extent that have low-risk critical CCTV scores.

3. Structural Defects and Adjacent Segments: Additional segments with identified structural defects and their adjacent segments in the main section of the Forwell Trunk.

4. Surcharged Downstream Segments: Downstream segments of the trunk near the WWTP that experience surcharging.

Based on these four criteria, four sections of the Forwell Trunk are proposed for remediation. These projects are recommended for inclusion in the Master Plan for budgeting purposes. However, further studies will be required to determine the preferred solution, confirm the costing, and assess any Environmental Assessment (EA) requirements. For the purposes of establishing the contingency allowance, each segment of the Forwell Trunk were costed based on a twinning solution using the same diameter pipe as is currently in place running parallel to the current sewer alignment. **Table 7-3** outlines the proposed twinning solution, including the recommended budgetary estimate, and **Figure 7-2** illustrates the locations of the proposed solutions.

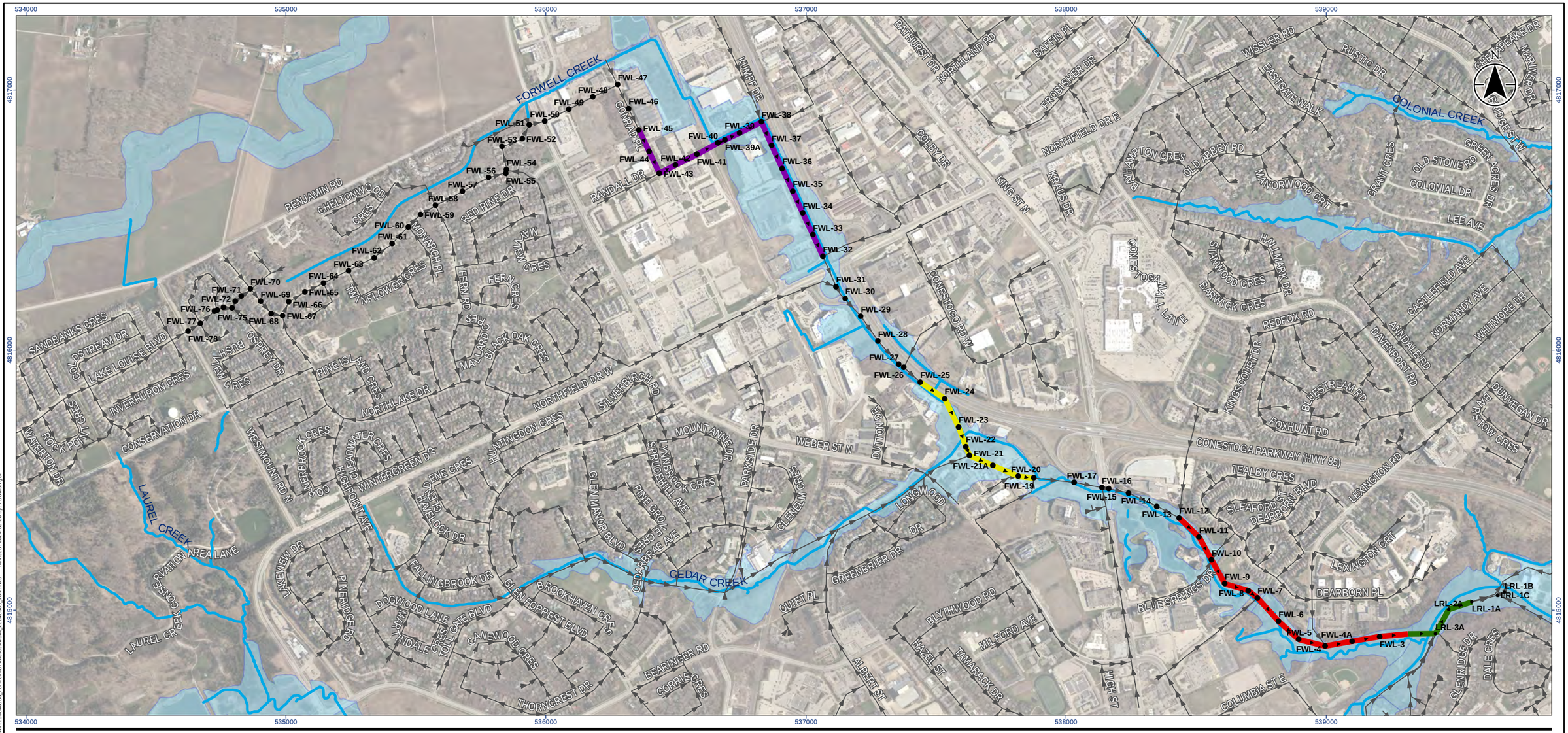
Table 7-3: Forwell Trunk Proposed Twinning Solution

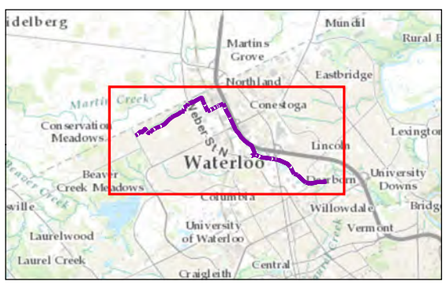
Forwell Project ID	Estimated Opinion of Probable Cost	Contingency Allowance (30%)	Engineering Allowance (20%)	Recommended Budgetary Estimate	Comments
Forwell Project 1	$8,276,100	$2,482,830	$2,151,786	$12,900,000	Project assumed to be completed entirely by micro tunnel methods with 4 separate bores.
Forwell Project 2	$3,045,675	$913,703	$791,876	$4,800,000	Micro tunnelling assumed for a single bore from FWL-22 to FWL-24, remainder of project completed by open cut.
Forwell Project 3	$2,454,070	$736,221	$638,058	$3,800,000	Open cut methods assumed with jack and bore across the rail crossing
Forwell Project 4	-	-	-	$2,000,000	Trunk near the WWTP interconnected in future works.

Note:

All projects are assumed to be a twinning of the existing sewer with the same diameter sewer as existing.

All projects assume no proactive dewatering is required with groundwater flows managed by pumps placed in the trench.





Legend

- GRCA Flow Gauge
- Creek
- Regulatory Floodplain
- Sanitary MH
- Other Sanitary Sewer
- Forwell Project 1
- Forwell Project 2
- Forwell Project 3
- Forwell Project 4

0 250 500 metres

1:15,000 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2018.
3. Orthoimagery © First Base Solutions, 2018. Imagery Date, 20XX.

Stantec

Project Location
Waterloo, ON

165640426 REVA
Prepared by HB on 2024-09-06
Technical Review by DE on 2024-04-30

Client/Project
CITY OF WATERLOO
SANITARY MASTER PLAN

Figure No.
7-2

Title
Proposed Forwell Trunk Twinning

Revised: 2024-09-06 By: hboularger
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7.1.3 Project Schedules (2015 Class EA Process)

The improvements recommended in this Master Plan will be implemented on the existing municipal infrastructure, within the municipal right-of-way. These capital upgrades are considered standard operational activities as per the 2015 MCEA Document. This is because the overall study was initiated and conducted following the Schedule B process under the 2015 Class EA guidelines in place at the start of the study.

However, it's important to note that the specific works recommended in **Table 7-4** adhere to the updated 2023 project schedule and fall under the Schedule A+ 'exempt' status. This is due to the amendments made to the MCEA process in 2023, which came into effect after the initiation of this study. Therefore, while the overall study follows the 2015 Class EA process, the future recommended works will align with the updated 2023 guidelines.

Table 7-4: MCEA Project Schedule Classification

Project ID	Project Description	MCEA Project Schedule
Highpoint Avenue	Capital upgrades to existing infrastructure. Modify, repair, reconstruct existing facilities to provide operational maintenance or other improvements.	Schedule 'A+'
Austin Drive	Capital upgrades to existing infrastructure. Modify, repair, reconstruct existing facilities to provide operational maintenance or other improvements.	Schedule 'A+'
Lodge Street	Capital upgrades to existing infrastructure. Modify, repair, reconstruct existing facilities to provide operational maintenance or other improvements.	Schedule 'A+'
Thorndale Drive & Westvale Drive	Reconfiguration of the existing weir structure. This involves a comprehensive redesign to optimize sanitary flow management.	Schedule 'A+'
Weber Street North	Do Nothing	Not Applicable
Forwell Trail	Capital upgrades to existing infrastructure (Twinning solutions)	Further study required under the MCEA Schedule
Frobisher Drive	Capital upgrades to existing infrastructure. Modify, repair, reconstruct existing facilities to provide operational maintenance or other improvements.	Schedule 'A+'
Union Street East	Capital upgrades to existing infrastructure. Modify, repair, reconstruct existing facilities to provide operational maintenance or other improvements.	Schedule 'A+'

7.2 IMPLEMENTATION AND TIMEFRAME

The Implementation Plan identifies works recommended in the Priority 5-year timeframe which are considered in more detail, separately from works identified for the Strategic 5-30-year window which are outlined at a higher level. The implementation plan consists of the timing of projects that were present in the previous sections. Moreover, the implementation plan spreads the capital works based on criticality to provide an annualized cost for the City's consideration. The project prioritization for the implementation strategy was formulated with a focus on areas that are most vulnerable to basement flooding. These high-risk zones were identified as critical problem areas. In addition, areas where the maximum number of residences could be impacted were also given priority. This approach ensures that the most at-risk and densely populated areas are addressed first in our plan.

Table 7-5 presents the prioritization (with 1 indicating highest priority) and annual costing for the short-term Capital Projects. Timing of the projects starts in 2027 to align with the City's multi-year budgeting cycle. Refer to **Sections 6.7** for details on the Capital Projects.

Table 7-5: Priority 5-year Timeframe Prioritization & Annual Costing

Project ID	Scenario Triggered	Recommended Budgetary Estimate	Priority	Priority 5-year					Strategic 5-30-year
				2027	2028	2029	2030	2031	
PA-1: Highpoint Avenue	Existing (Near-Term Priority)	$3,004,000	1	$3,004,000	$-	$-	$-	$-	$-
PA-2: Austin Drive	Existing (Near-Term Priority)	$1,185,000	1	$-	$1,185,000	$-	$-	$-	$-
PA-3: Lodge Street	Existing (Near-Term Priority)	$2,061,000	2	$-	$-	$2,061,000	$-	$-	$-
PA-4: Thorndale Drive & Westvale Drive	Existing (Near-Term Priority)	$105,000	3	$-	$-	$-	$105,000	$-	$-
PA-5: Weber Street North	Existing (Near-Term Priority)	$-	-	$-	$-	$-	$-	$-	$-
PA-6: Forwell Trail	Existing (Near-Term Priority)	$-	-	$-	$-	$-	$-	$-	$-
Forwell Trunk	Existing (Near-Term Priority)	$23,500,000	4						$23,500,000
PA-7: Frobisher Drive	Existing (Near-Term Priority)	$690,000	4	$-	$-	$-	$-	$690,000	$-
PA-8: Union Street East	**2031 (Medium-Term Priority)**	$612,000	5	$-	$-	$-	$-	$-	$612,000
			Total	**$3,004,000**	**$1,185,000**	**$2,061,000**	**$105,000**	**$690,000**	**$24,112,000**

8.0 CONCLUSIONS AND RECOMMENDATIONS

The City of Waterloo Sanitary Sewer System Master Plan aims to accommodate projected population and employment increases up to 2051 and provide municipal services to privately serviced properties. The plan outlines priority and strategic projects to ensure the system's efficient operation, including best management practices for reducing Inflow/Infiltration (I/I), system rehabilitation, and optimizing the sanitary capital program.

The Master Plan includes individual projects categorized into Priority Projects, recommended for completion within the next five-year cycle, and Strategic Projects, outlined at a higher level for a 5 to 30-year window. These projects involve capital upgrades to existing infrastructure at locations where capacity constraints have been identified within the sanitary sewer network.

The estimated costs for these capital upgrades, including a Capital Cost Contingency and a Project Delivery Allowance. The total cost for the Priority Projects for 2027 to 2031 is $7,045,000, and the cost for the Strategic Projects is $24,112,000.

All projects identified in the study are classified as Schedule A+ and do not require further study, allowing the City to proceed to detailed design and construction. This Master Plan update was conducted following the 2015 Class EA process, originally as a Schedule B project. However, the recommended projects will adhere to the updated 2023 MCEA process and fall under the Schedule A+ 'exempt' status. This ensures the City of Waterloo is prepared to meet future sanitary sewer system needs.

However, the Forwell Trunk Twinning solutions require further study to determine the preferred solution, confirm the costing, and assess any EA requirements.